(2)

Final Report

JANUARY 1989

EVT 13-89

BOXCAR TRANSPORTABILITY ENGINEERING TEST OF PROPELLING CHARGE PLASTIC CONTAINERS ON METAL PALLETS

Prepared For:

U.S. Army Armament Research, Development
and Engineering Center
ATTN: SMCAR-AEP
Picatinny Arsenal, NJ 07806-5000

EVALUATION DIVISION
SAVANNA, ILLINOIS 61074-9639

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The U.S. Army Defense Ammunition Center and School (USADACS) was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC) to design a unitization system for M203 155mm propelling charge plastic containers. The unitization system, consisting of a standard metal pallet, pallet adapter, spacing posts, and a top lift assembly was previously tested and met the requirements of MIL-STD-1660, Design Criteria for Ammunition Loads. Propelling charge plastic containers on a standard metal pallet have not previously been tested in a rail transportation environment. This engineering test, based on a blocking and bracing procedure developed by the Storage and Outloading Division (SMCAC-DEO), was performed to determine the adequacy of the unitization in a rail transportation environment.
(CONT)

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19. Abstract (CONT)

To accomplish this procedure, a 50-foot boxcar was center loaded with propelling charge plastic container pallets. Two test configurations were used. The first test consisted of orienting the containers parallel in the direction of impact. The second test had the pallet skids and containers perpendicular to the direction of impact. Each configuration was subjected to impacts of 4, 6 and 8 miles per hour (mph) in a forward direction and one impact at 8 mph in the reverse direction.

The first configuration was tested on 10 January 1989. The load configuration consisted of 24 pallets of propelling charge containers in the rear of the boxcar and 6 PA116 standard metal pallets used for filler at the impact end of the car. Two biaxial accelerometers were installed; one on the boxcar floor and the other on the top of the third pallet from the rear. The test load experienced peak accelerations of 4.67 g's on the floor and 5.38 g's on the top of the third pallet.

The second configuration was tested on 12 January 1989. The load configuration consisted of 24 pallets of propelling charge containers. Two biaxial accelerometers were installed; one on the boxcar floor and the other on top of the third pallet from the rear. The test load experienced peak accelerations of 2.91 g's on the floor and 6.8 g's on top of the pallet.

After impacting with the pallets in longitudinal orientation, the boxcar was unloaded. The only damage experienced was a scuffing of the propelling charge plastic container bases. Two pallets on the upper pallets became disengaged from the stacking lugs. Based on this test, rail transportation in the longitudinal configuration is acceptable.

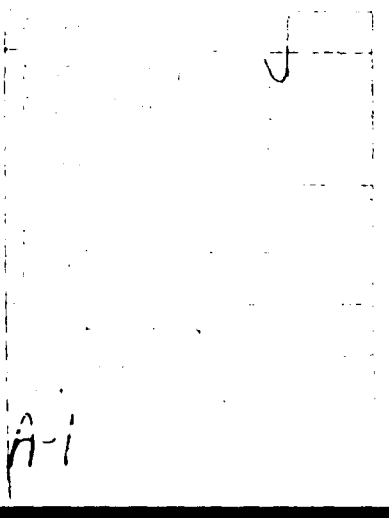
After impacting with the pallets in the lateral orientation, the boxcar was unloaded. No damage was observed. Also, no damage was observed on the propellant plastic container on metal pallets after impacting in the lateral orientation. The remainder of this report contains detailed information about the rail impact test including: test car data, weights, acceleration, velocity and displacement data, and the blocking and bracing procedures for longitudinal and lateral pallet orientations.

U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
Evaluation Division
Savanna, IL 61074-9639

REPORT NO. EVT 13-89

BOXCAR TRANSPORTABILITY ENGINEERING TEST OF PROPELLING CHARGE PLASTIC CONTAINERS ON METAL PALLETS

TABLE OF CONTENTS



PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC) to design a unitization system for M203 155mm propelling charge plastic containers. When the unitization system design was completed, it was tested and met the requirements of MIL-STD-1660, Design Criteria for Ammunition Unit Loads. In order to further ensure satisfactory design performance over the logistics life of the M203 155mm propelling charge plastic container unitization, testing in a rail transportation environment was required.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by ARDEC, U.S. Army Armament, Munitions and Chemical Command (AMCCOM), and AR740-1.

C. OBJECTIVE. The objective of this engineering test is to determine the boxcar transportability of propelling charge plastic containers on metal pallets.

PART 2

ATTENDEES

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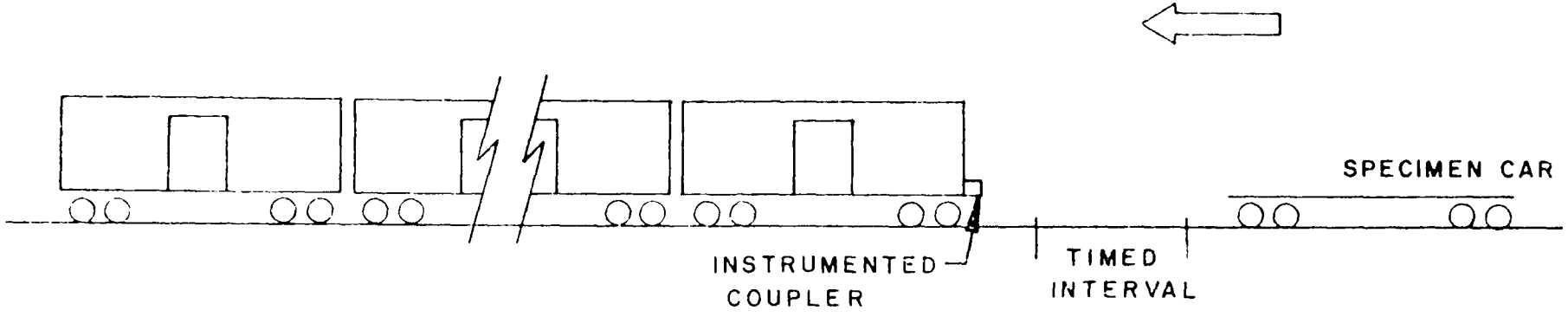
PART 3

TEST PROCEDURES

RAIL IMPACT TEST. The test load or vehicle should be positioned in/on a railcar. The loaded container shall be positioned on a container chassis and securely locked in place using the twist locks at each corner. The container chassis shall be secured to a railcar. Equipment needed to perform the test includes the specimen (hammer) car, five empty railroad cars connected together to serve as the anvil, and a railroad locomotive. These anvil cars are positioned on a level section of track with air and hand brakes set and with the draft gear compressed. The locomotive unit pulls the specimen car several hundred yards away from the anvil cars and, then, pushes the specimen car toward the anvil at a predetermined speed, disconnects from the specimen car about 50 yards away from the anvil cars and allows the specimen car to roll freely along the track until it strikes the anvil. This constitutes an impact. Impacting is accomplished at speeds of 4, 6, and 8 mph in one direction and at a speed of 8 mph in the opposite direction. The 4 and 6 mph impact speeds are approximate; the 8 mph speed is a minimum. Impact speeds are to be determined by using an electronic counter to measure the time required for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars.

ASSOCIATION OF AMERICAN RAILROADS (AAR)
STANDARD TEST PLAN



5 BUFFER CARS WITH DRAFT GEAR
COMPRESSED AND AIR BRAKES IN
A SET POSITION

BUFFER CAR TOTAL WT 250,000 LBS (APPROX)

SPECIMEN CAR
IS RELEASED BY
SWITCH ENGINE AT:

IMPACT NO. 1 4 MPH
IMPACT NO. 2 6 MPH
IMPACT NO. 3 8 MPH

THEN CAR IS REVERSED
AND RELEASED AT

IMPACT NO. 4 8 MPH

PART 4

TEST EQUIPMENT

1. TEST SPECIMEN

   a. M203 155mm Plastic Propelling Charge Unitization

      (1) Length: 47 inches

      (2) Width: 37 inches

      (3) Height: 52 inches

      (4) Weight: 1,800 pounds

      (5) Quantity: 24 each

   b. Inert Filler Pallets

      (1) Weight: 2,400 pounds

      (2) Quantity: 12 each

   c. Box Car, 50 feet long

      (1) Car Number: BN 249,341

      (2) Capacity: 154,000 pounds

      (3) LD. LMT: 161,000 pounds

      (4) LT. WT: 59,000 pounds

      (5) Manufacturer: Pullman Standard, Bessemer, CA., Lot 9831

2. TRACK TIMER

3. DATA ACQUISITION

   a. Accelerometers - 5 each

   b. Instrumentation Pack

   c. Honeywell 5600c tape recorder

4. DATA ANALYSIS EQUIPMENT

   a. Zenith AT Microprocessor

   b. Software - ASYST

PART 5

TEST RESULTS

PART 5

TEST RESULTS

Two series of impact tests were performed. One series of impacts was accomplished with the test specimen pallets oriented longitudinal to the direction of impact; and in the second series, the orientation was lateral to the direction of impact. The following sections contain the results of these tests.

RAIL IMPACT TEST NO 1. DATE: 10 JANUARY 1989

TEST SPECIMEN: M203, 155MM PROPELLING CHARGE PLASTIC CONTAINERS

TEST BOXCAR NO. BN 249,341 LT. WT. 59,000 pounds

LADING AND DUNNAGE WT. 60,700 pounds

TOTAL SPECIMEN WT. 119,700 pounds

BUFFER CAR (5 CARS) WT. 220,000 pounds

IMPACT NO.	END STRUCK	VELOCITY (MPH)	REMARKS
1	forward	4.45	1. Load shifted toward impact end 3 inches. 2. Dunnage broken at center gate.
2	forward	6.41	Load shifted toward impact end 1/2-inch.
3	forward	8.49	1. Broken dunnage at center gate side rail. Not critical to load restraint. 2. Second layer pallet, third from rear end disengaged stacking lugs.
4	reverse	8.59	1. Load shifted 3-1/2 inches to close up gap from previous impacts 2. Two pallets disengaged from stacking lugs.

RESULTS FROM THE RAIL IMPACT TEST ON
PLASTIC M203 CONTAINERS ON METAL PALLET IN
CONFIGURATION #1, DATE: 10 JANUARY 1989

TAPE CHANNEL 3 : LONGITUDINAL ACCELERATION ON CAR BED

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.49	1.71	53.63	.0603
IMPACT 2	6.41	2.43	33.76	.0529
IMPACT 3	8.40	4.08	21.32	.0558
IMPACT 4 (REVERSE)	8.31	-3.38	46.77	.0830

TAPE CHANNEL 4 : VERTICAL ACCELERATION ON CAR BED

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.49	-.26	5.63	.0000
IMPACT 2	6.41	-.41	6.76	.0013
IMPACT 3	8.40	-1.14	10.10	.0053
IMPACT 4 (REVERSE)	8.31	-2.28	16.52	.0234

TAPE CHANNEL 5 : LONGITUDINAL ACCELERATION ON TOP LAYER PALLET

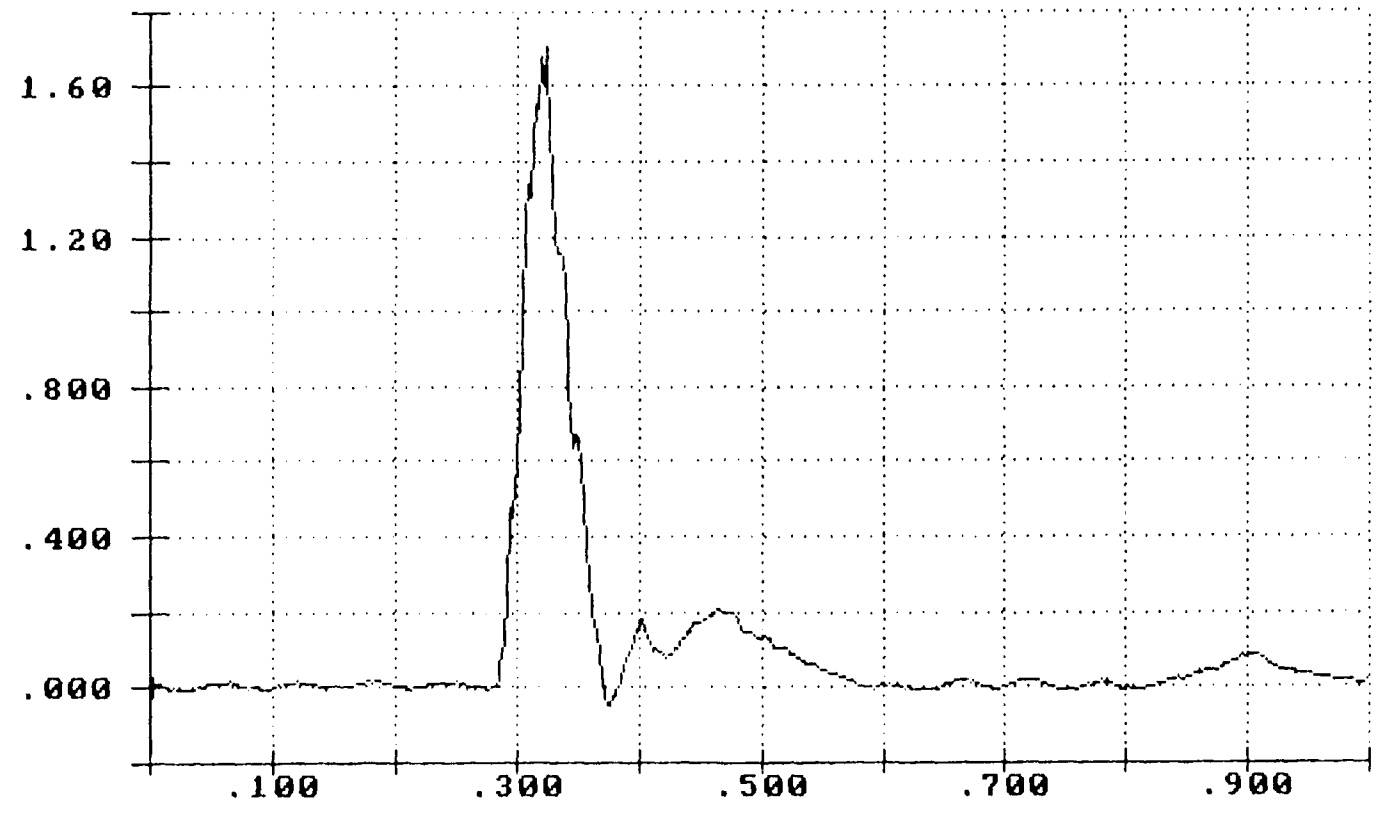
TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.49	3.27	27.06	.0680
IMPACT 2	6.41	3.15	103.55	.1205
IMPACT 3	8.40	4.24	70.73	.1775
IMPACT 4 (REVERSE)	8.31	-5.38	32.05	.1013

TAPE CHANNEL 6 : VERTICAL ACCELERATION ON TOP LAYER PALLET

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.49	-.47	7.32	.0023
IMPACT 2	6.41	-.57	23.30	.0138
IMPACT 3	8.40	.58	25.57	.0110
IMPACT 4 (REVERSE)	8.31	-1.68	9.84	.0100

RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS

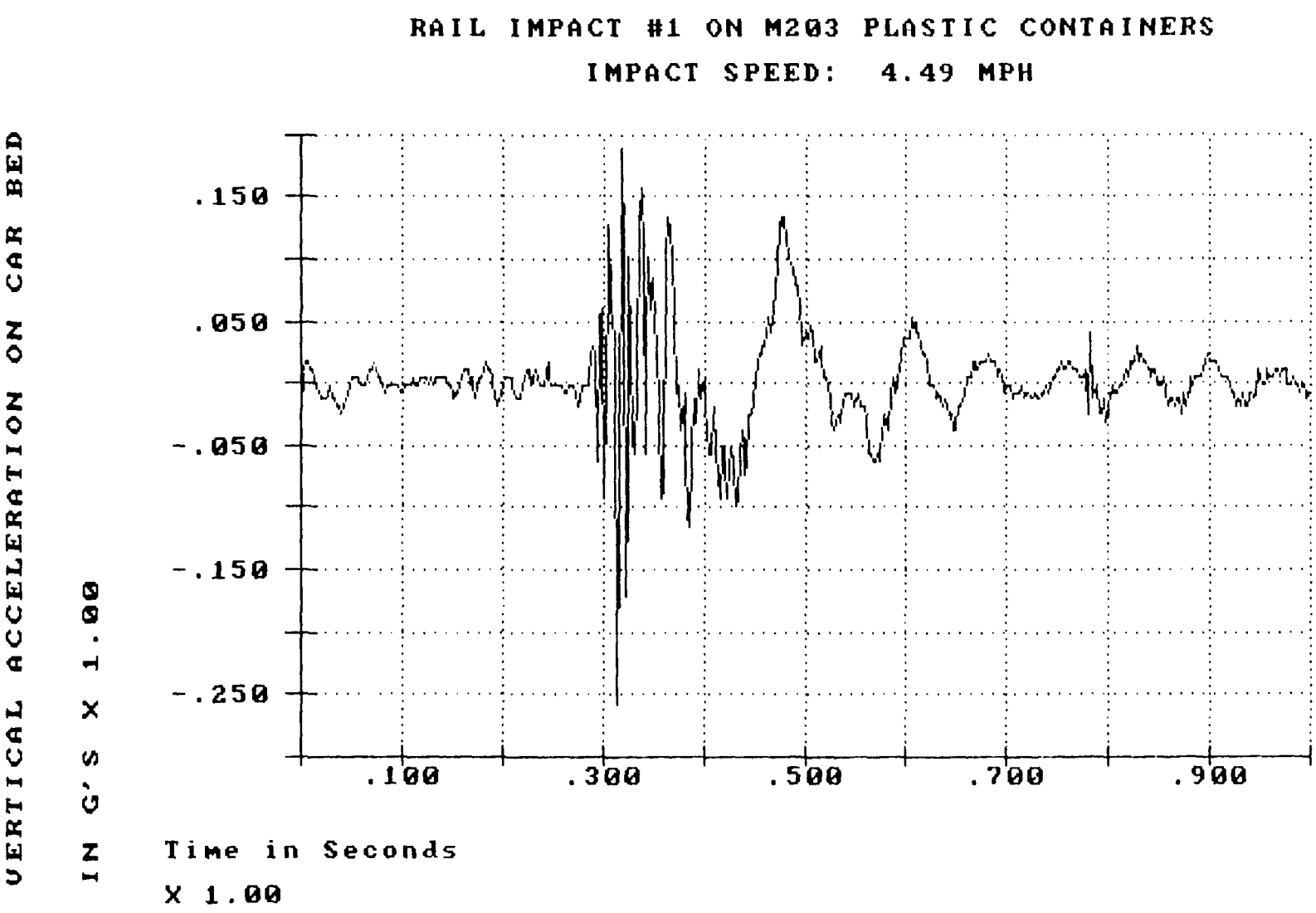
IMPACT SPEED: 4.49 MPH



LONGITUDINAL ACCELERATION ON CAR-BED IN G'S X 1.00

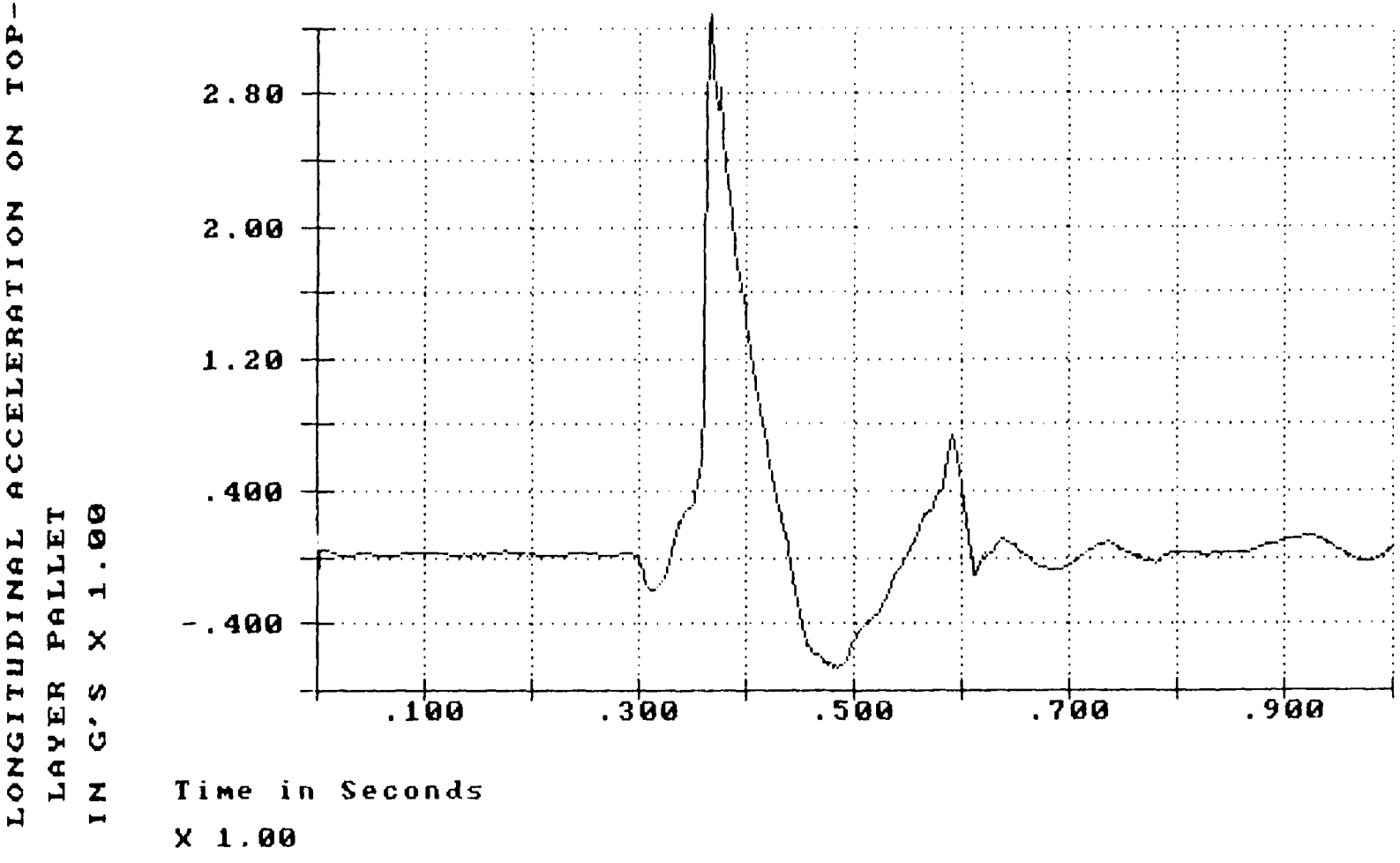
Time in Seconds

X 1.00


RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS
IMPACT SPEED: 4.49 MPH
VERTICAL ACCELERATION ON CAR BED
IN G'S X 1.00
.150
.050
-.050
-.150
-.250
.100
.300
.500
.700
.900
Time in Seconds
X 1.00

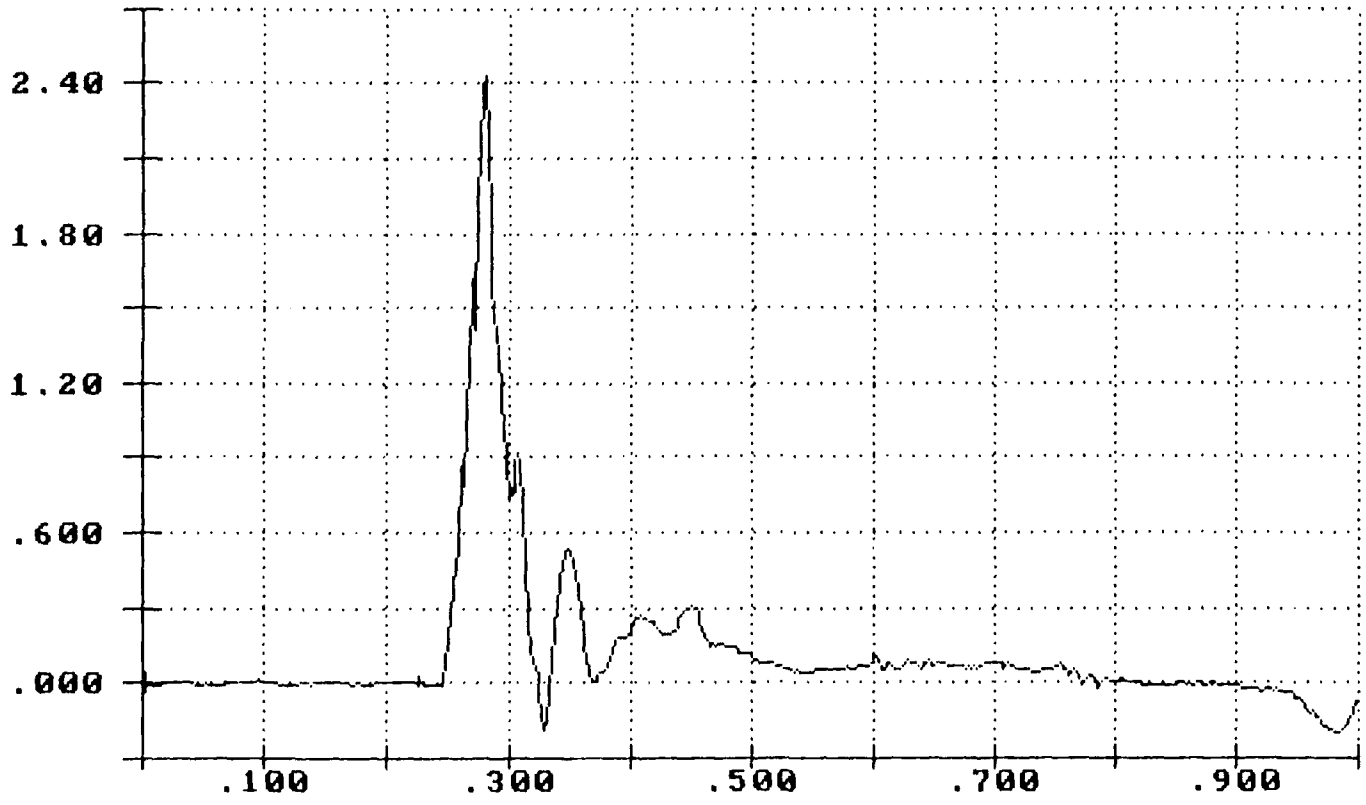
RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 4.49 MPH



RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 6.41 MPH



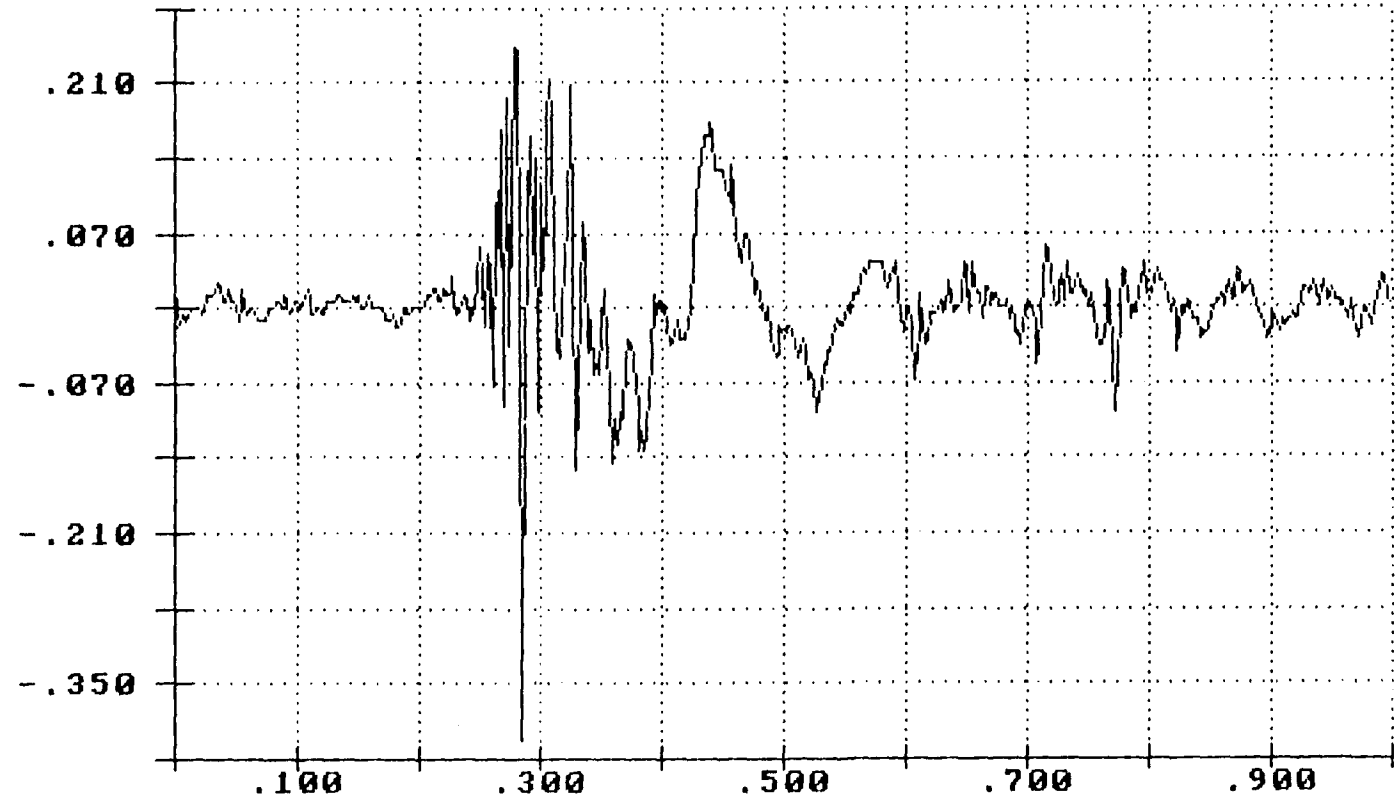
LONGITUDINAL ACCELERATION ON CAR-BED IN G'S X 1.00

Time in Seconds

X 1.00

RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 6.41 MPH

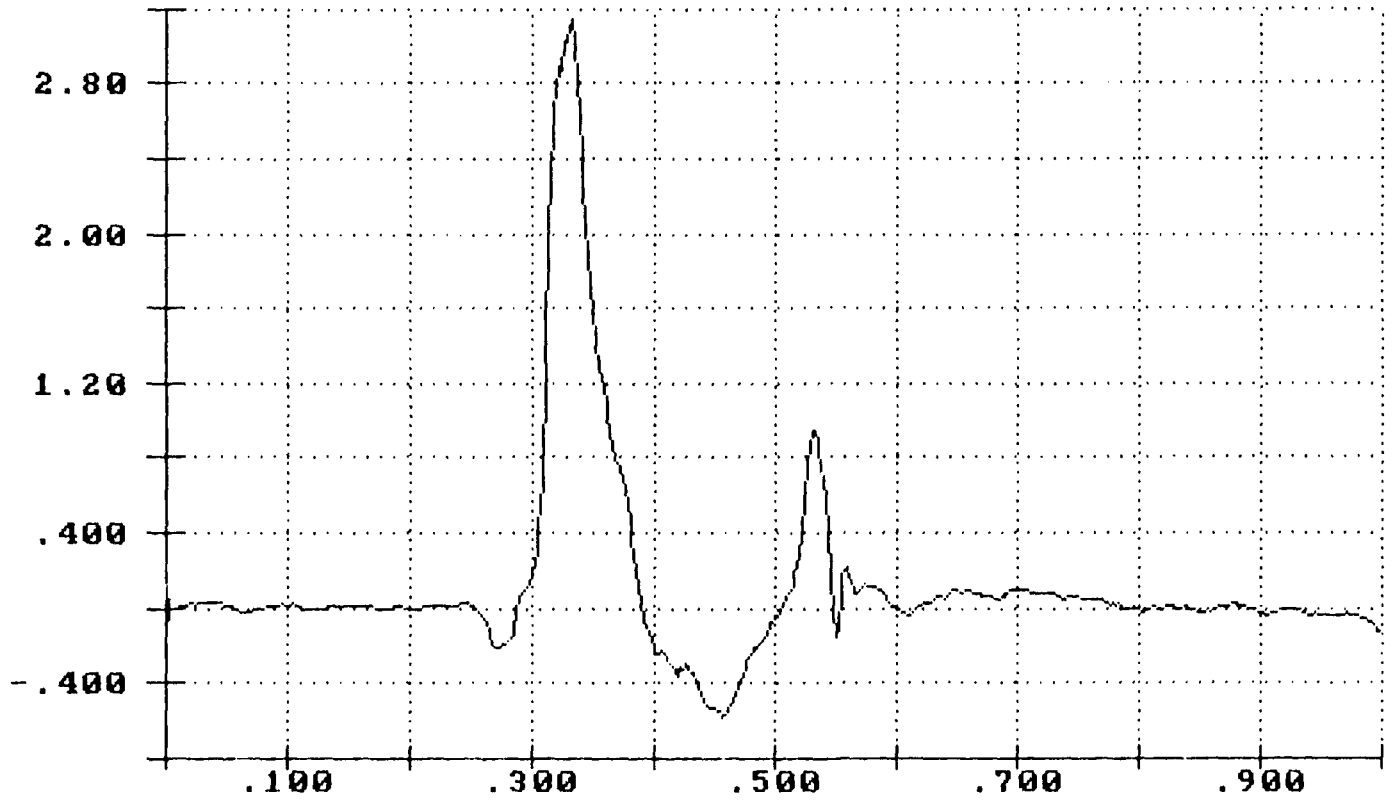


VERTICAL ACCELERATION ON CAR BED IN G'S X 1.00

Time in Seconds X 1.00

RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 6.41 MPH



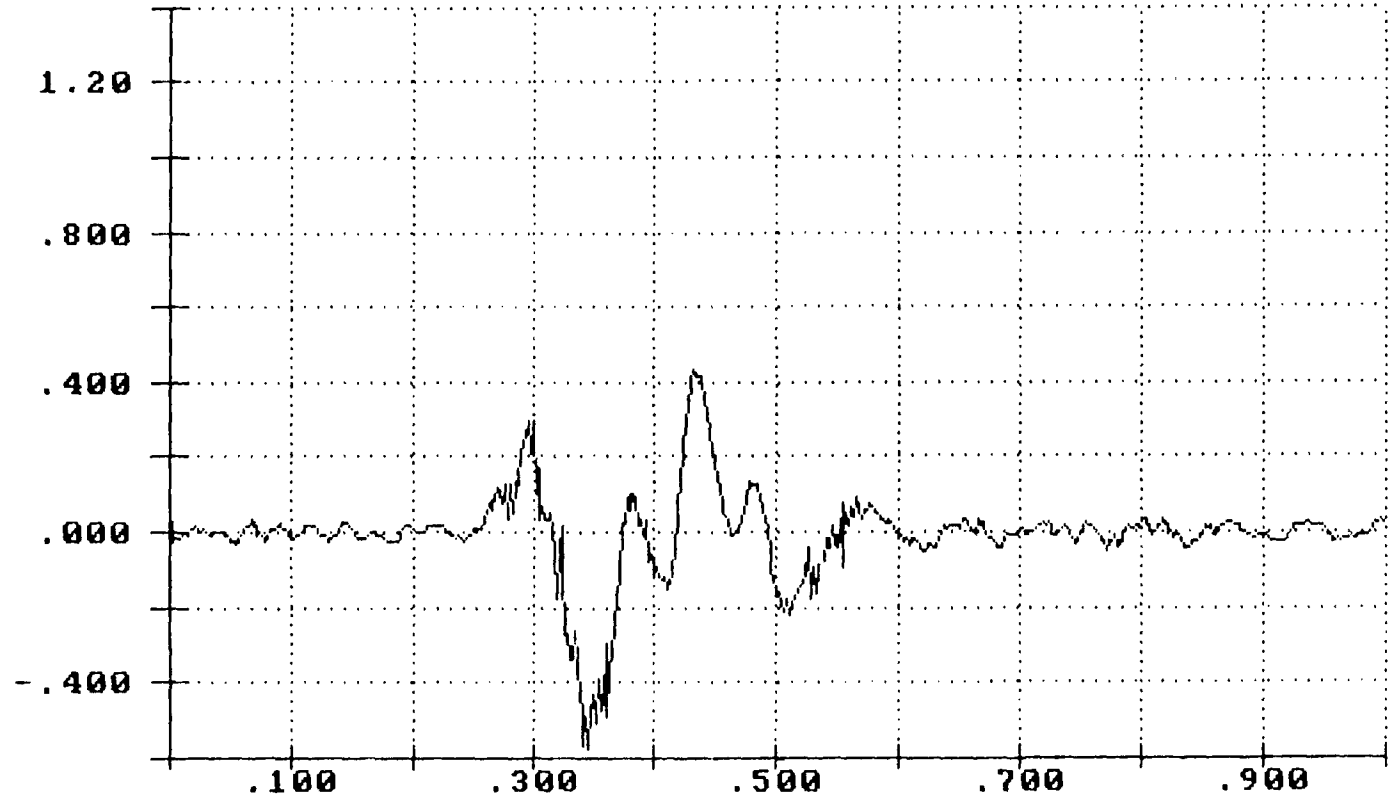
LONGITUDINAL ACCELERATION ON TOP-LAYER PALLET IN G'S X 1.00

Time in Seconds

X 1.00

RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 6.41 MPH



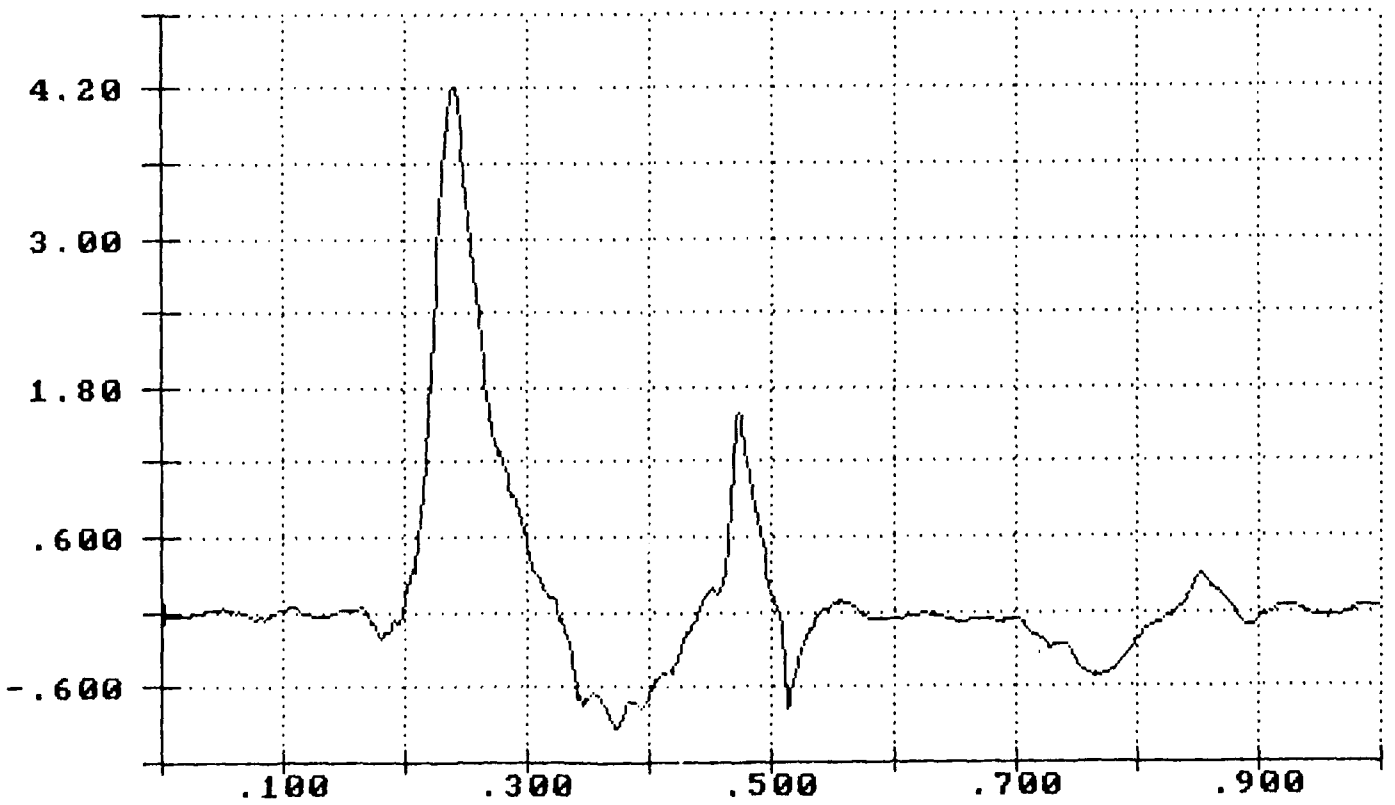
VERTICAL ACCELERATION ON TOP LAYER PALLET IN G'S X 1.00

Time in Seconds

X 1.00

RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 8.40 MPH



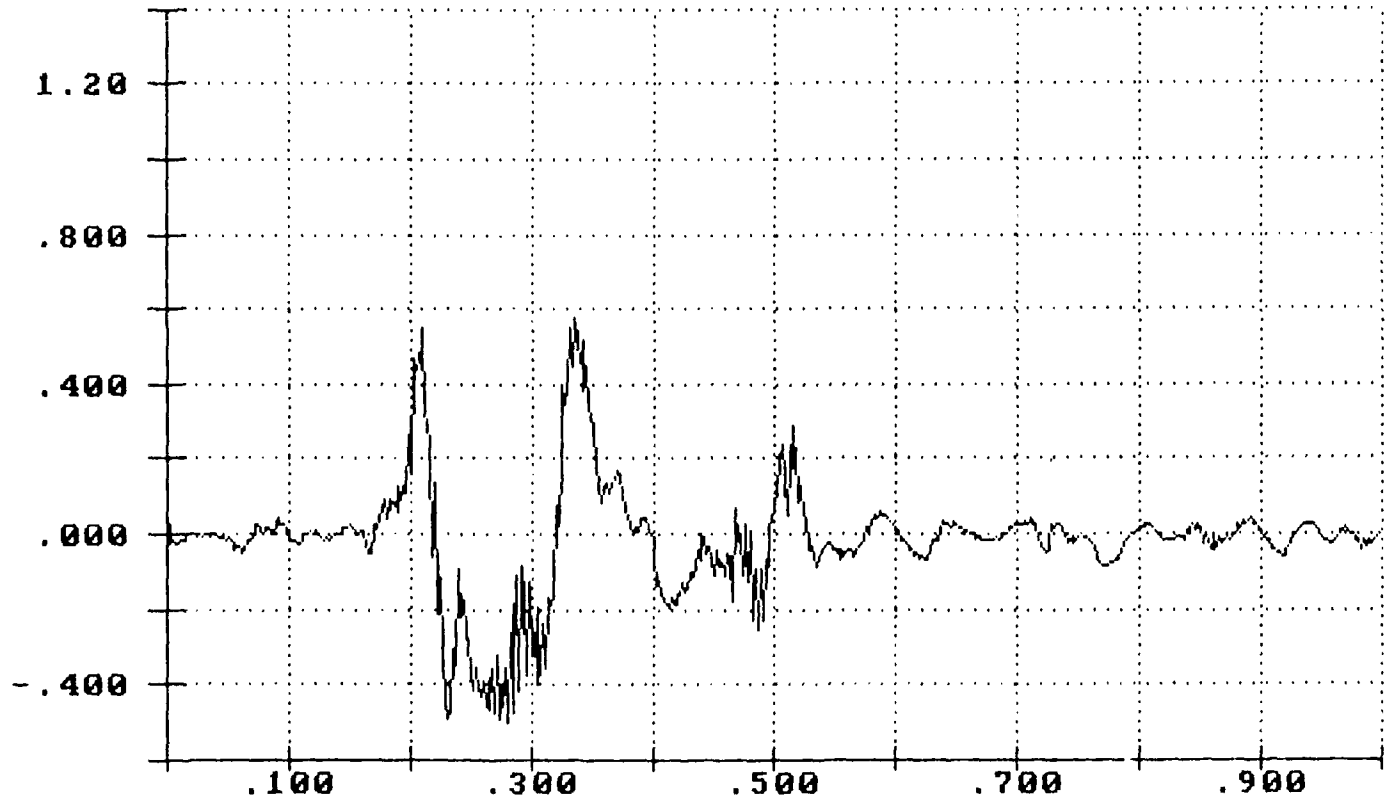
LONGITUDINAL ACCELERATION ON TOP-LAYER PALLET IN G'S X 1.00

Time in Seconds

X 1.00

RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 8.40 MPH



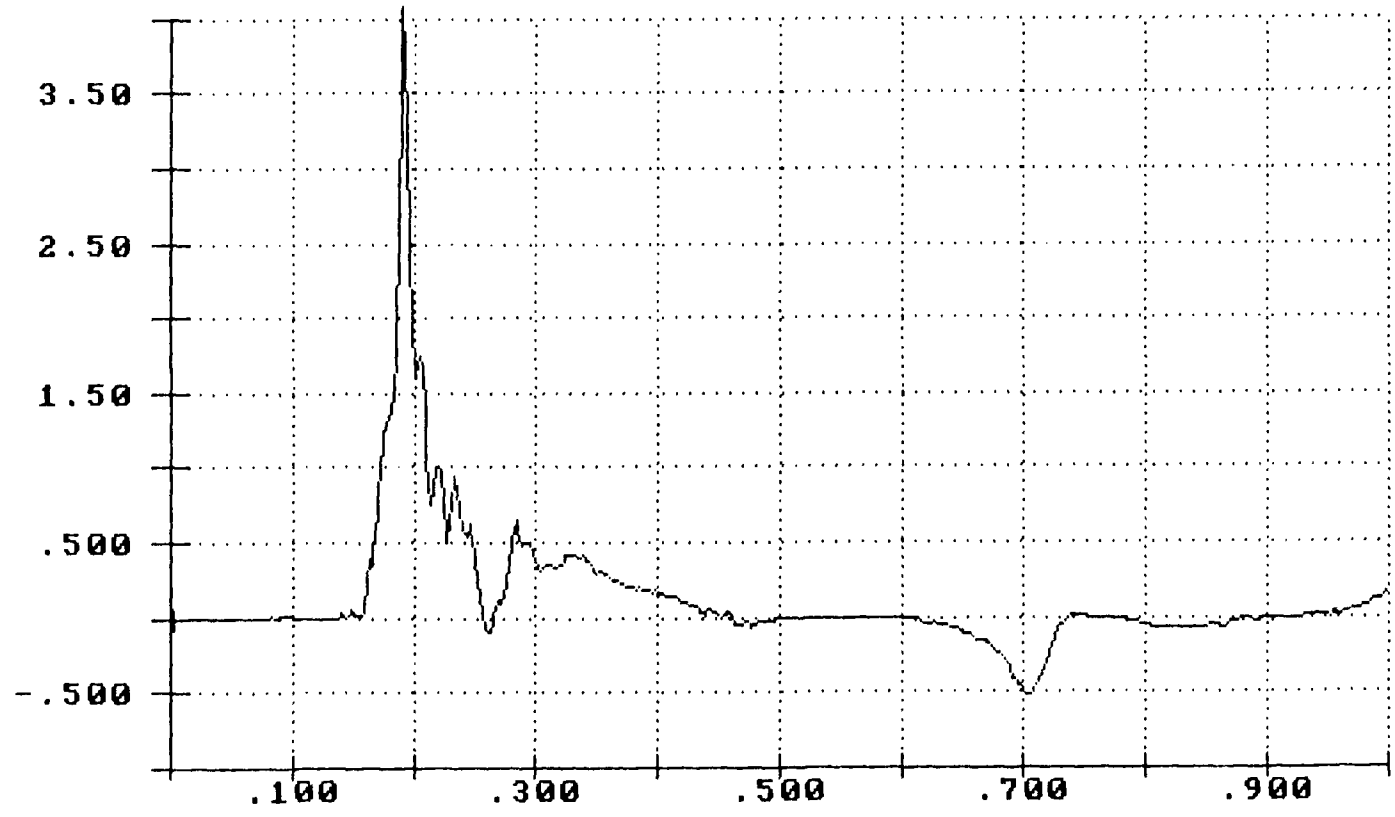
VERTICAL ACCELERATION ON TOP LAYER PALLET IN G'S X 1.00

Time in Seconds

X 1.00

RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 8.40 MPH

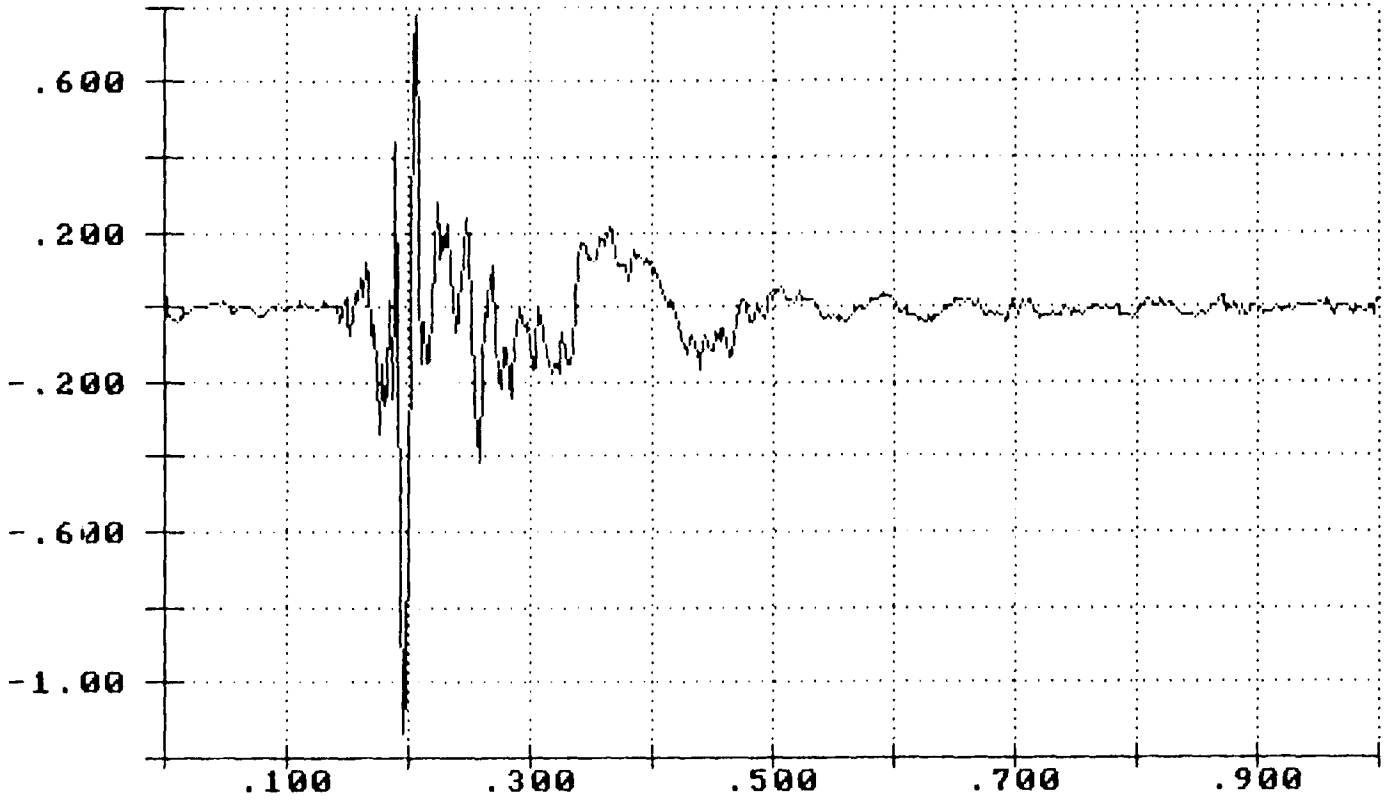


LONGITUDINAL ACCELERATION ON CAR-BED IN G'S X 1.00

Time in Seconds
X 1.00

RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 8.40 MPH

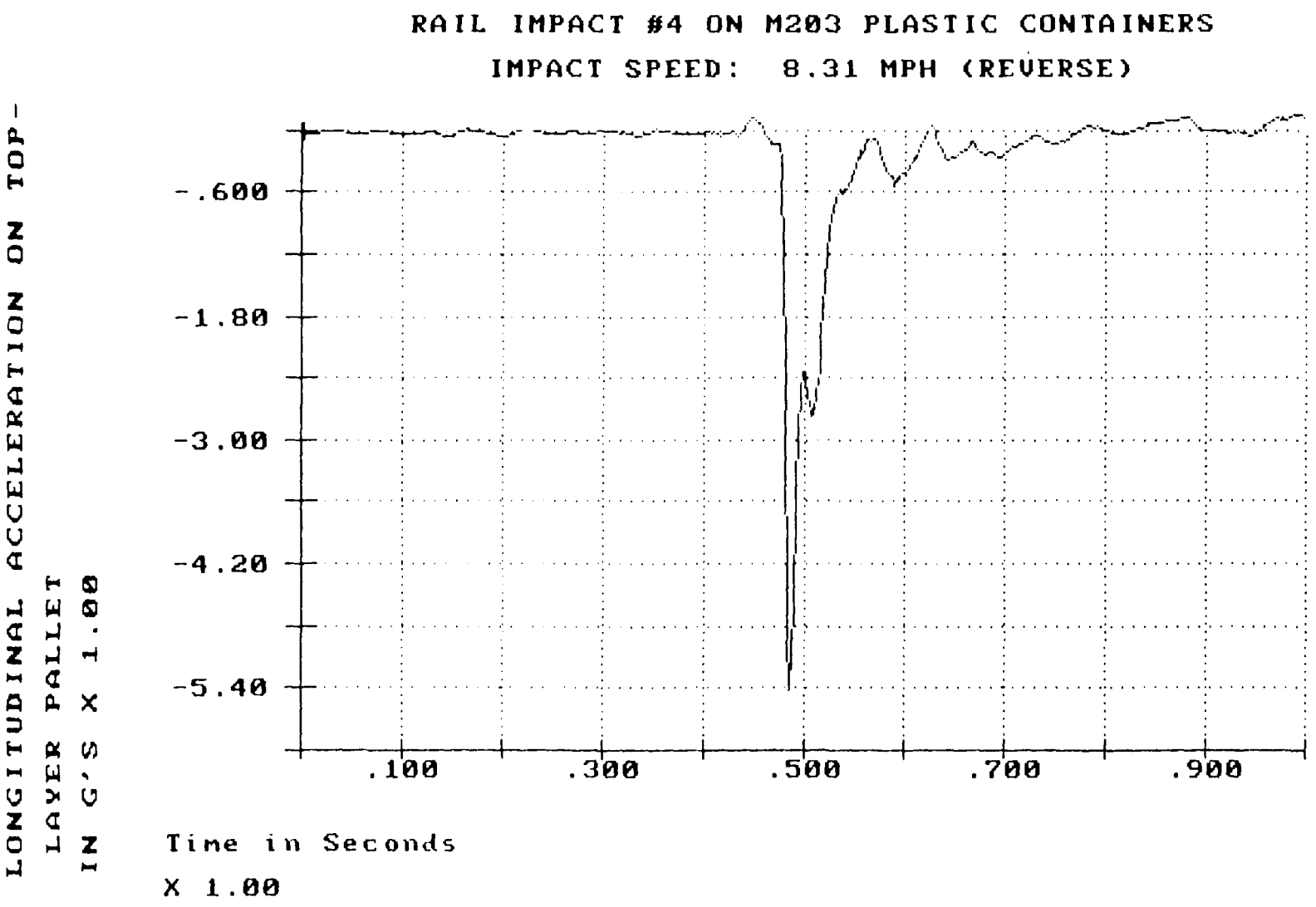


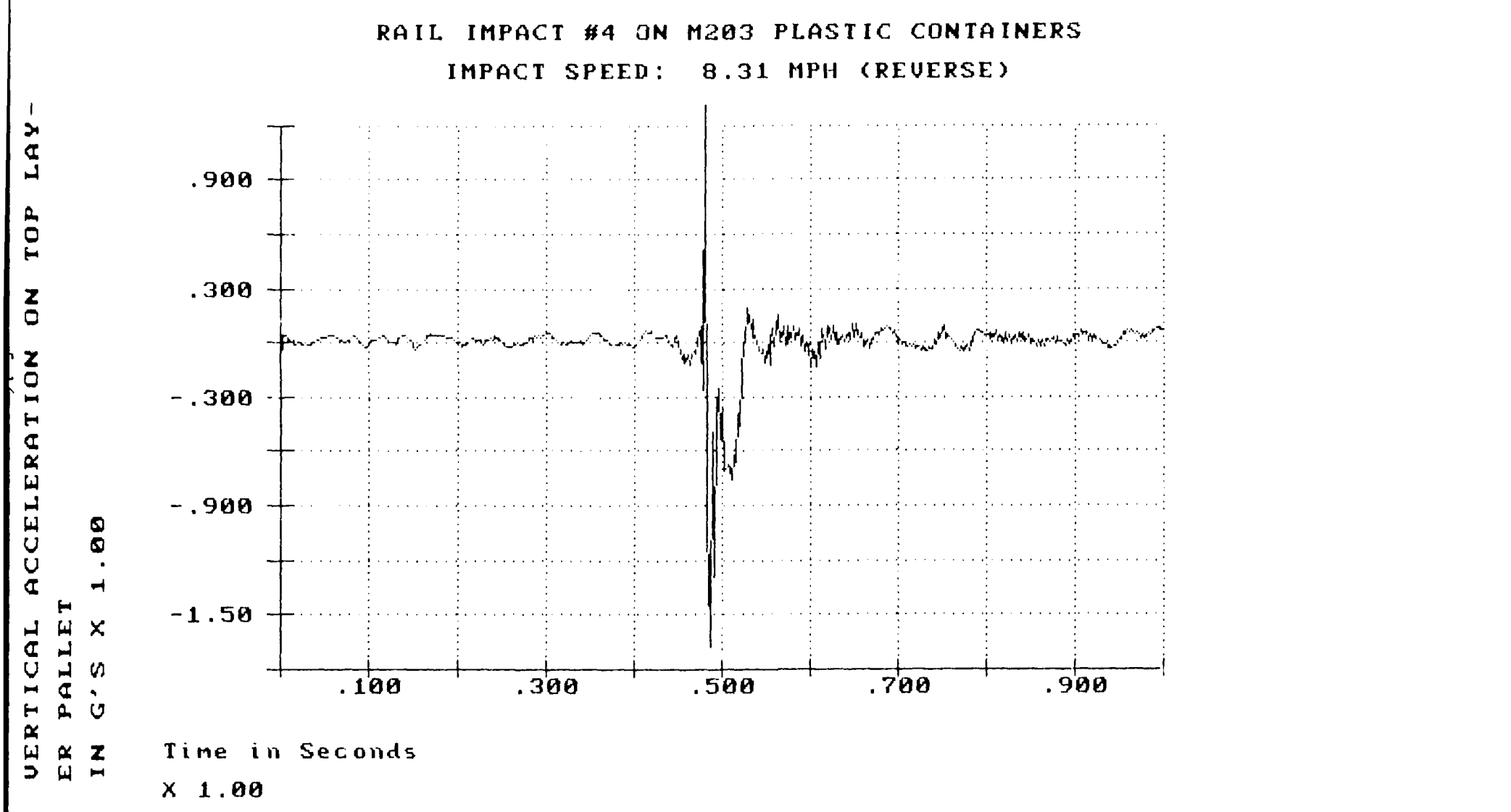
VERTICAL ACCELERATION ON CAR BED

IN G'S X 1.00

Time in Seconds

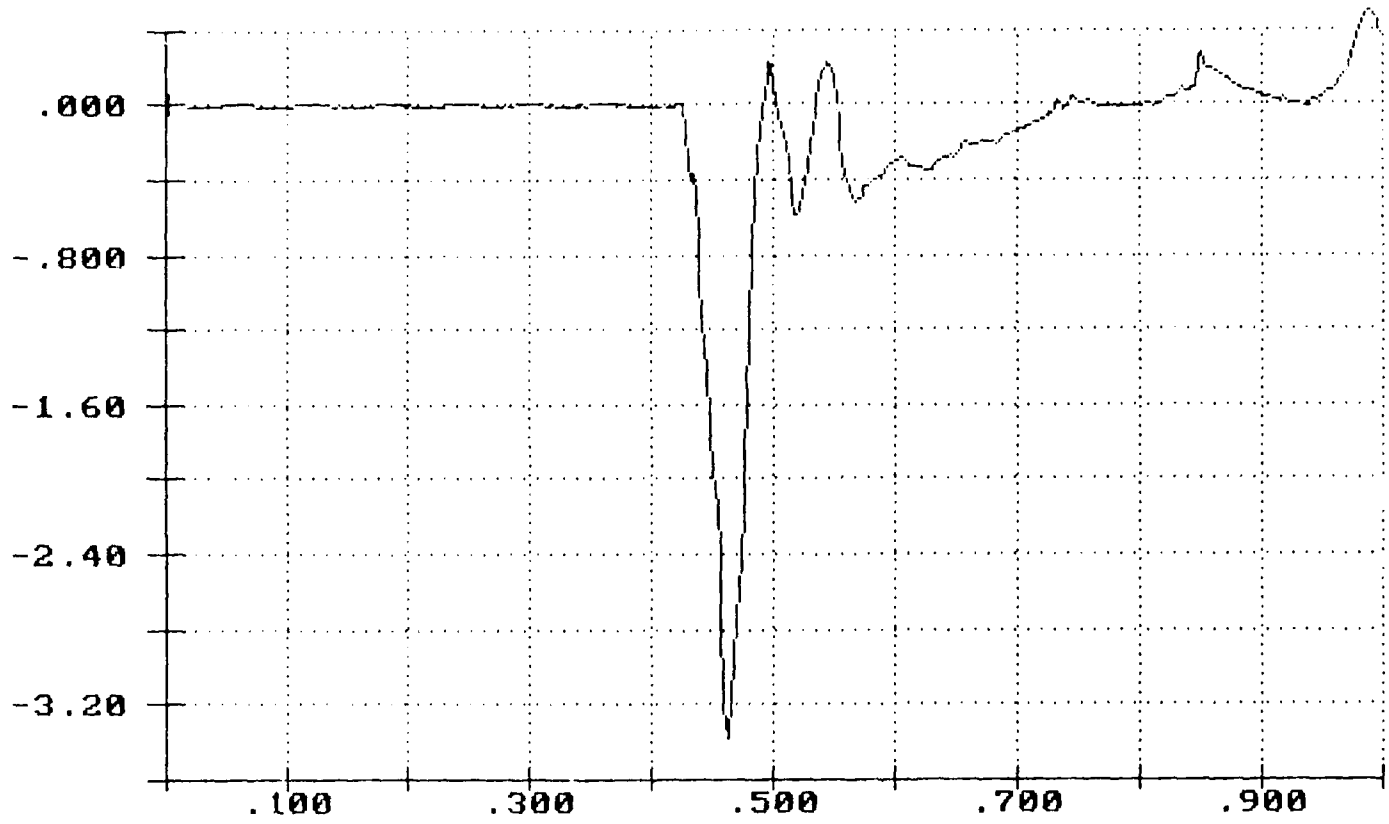
X 1.00


RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS
IMPACT SPEED: 8.31 MPH (REVERSE)
LONGITUDINAL ACCELERATION ON TOP-
LAYER PALLET
IN G'S X 1.00
-.600
-1.80
-3.00
-4.20
-5.40
.100
.300
.500
.700
.900
Time in Seconds
X 1.00


RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS
IMPACT SPEED: 8.31 MPH (REVERSE)
VERTICAL ACCELERATION ON TOP LAYER PALLET IN G'S X 1.00
.900
.300
-.300
-.900
-1.50
.100
.300
.500
.700
.900
Time in Seconds
X 1.00

RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 8.31 MPH (REVERSE)



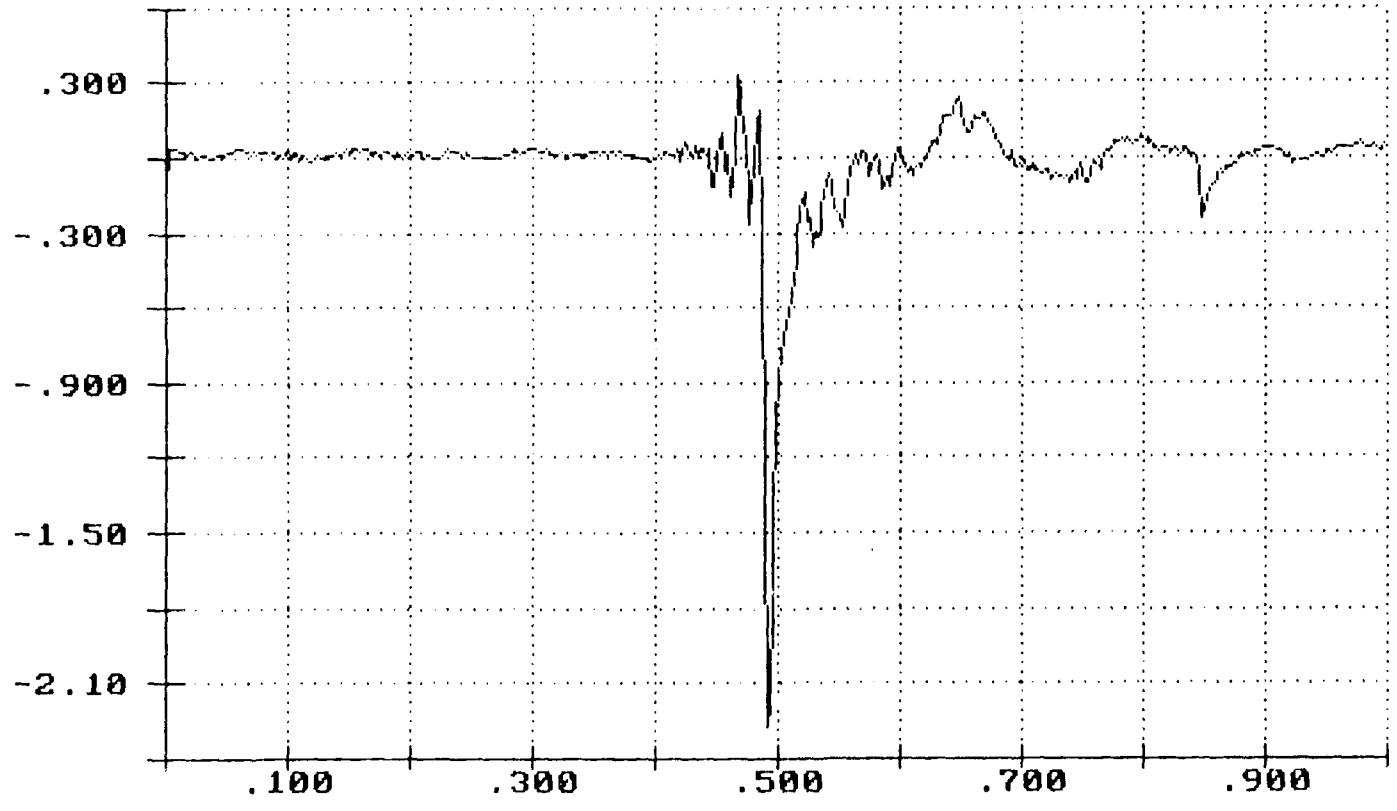
LONGITUDINAL ACCELERATION ON CAR-BED IN G'S X 1.00

Time in Seconds

X 1.00

RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 8.31 MPH (REVERSE)



VERTICAL ACCELERATION ON CAR BED

IN G'S X 1.00

Time in Seconds

X 1.00

PART 5

TEST RESULTS

RAIL IMPACT TEST DATE: 10 JANUARY 1989

TEST SPECIMEN: M203, 155MM PROPELLING CHARGE PLASTIC CONTAINERS
LATERAL ORIENTATION

TEST BOXCAR NO. BN 249,341 LT. WT. 59,000 pounds

LADING AND DUNNAGE WT. 60,700 pounds

TOTAL SPECIMEN WT. 119,700 pounds

BUFFER CAR (5 CARS) WT. 220,000 pounds

IMPACT NO.	END STRUCK	VELOCITY (MPH)	REMARKS
1	forward	4.22	Load shifted toward impact end 1 inch.
2	forward	6.31	Load shifted toward impact end 1/2 inch.
3	forward	8.47	No load movement
4	reverse	8.36	1. Load shifted 2 inches to close up gap. 2. No damage or excessive load movement.

RESULTS FROM THE RAIL IMPACT TEST ON
PLASTIC M203 CONTAINERS ON METAL PALLET IN
CONFIGURATION #2, DATE: 12 JANUARY 1989

TAPE CHANNEL 3 : LONGITUDINAL ACCELERATION ON CAR BED

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.22	1.93	50.17	.0510
IMPACT 2	6.31	2.60	25.25	.0429
IMPACT 3	8.47	2.60	37.99	.0662
IMPACT 4 (REVERSE)	8.36	-2.89	35.56	.0675

TAPE CHANNEL 4 : VERTICAL ACCELERATION ON CAR BED

TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.22	-.24	20.96	.0041
IMPACT 2	6.31	.46	10.05	.0028
IMPACT 3	8.47	-.47	16.97	.0040
IMPACT 4 (REVERSE)	8.36	-.32	17.49	.0034

TAPE CHANNEL 5 : LONGITUDINAL ACCELERATION ON TO LAYER PALLET

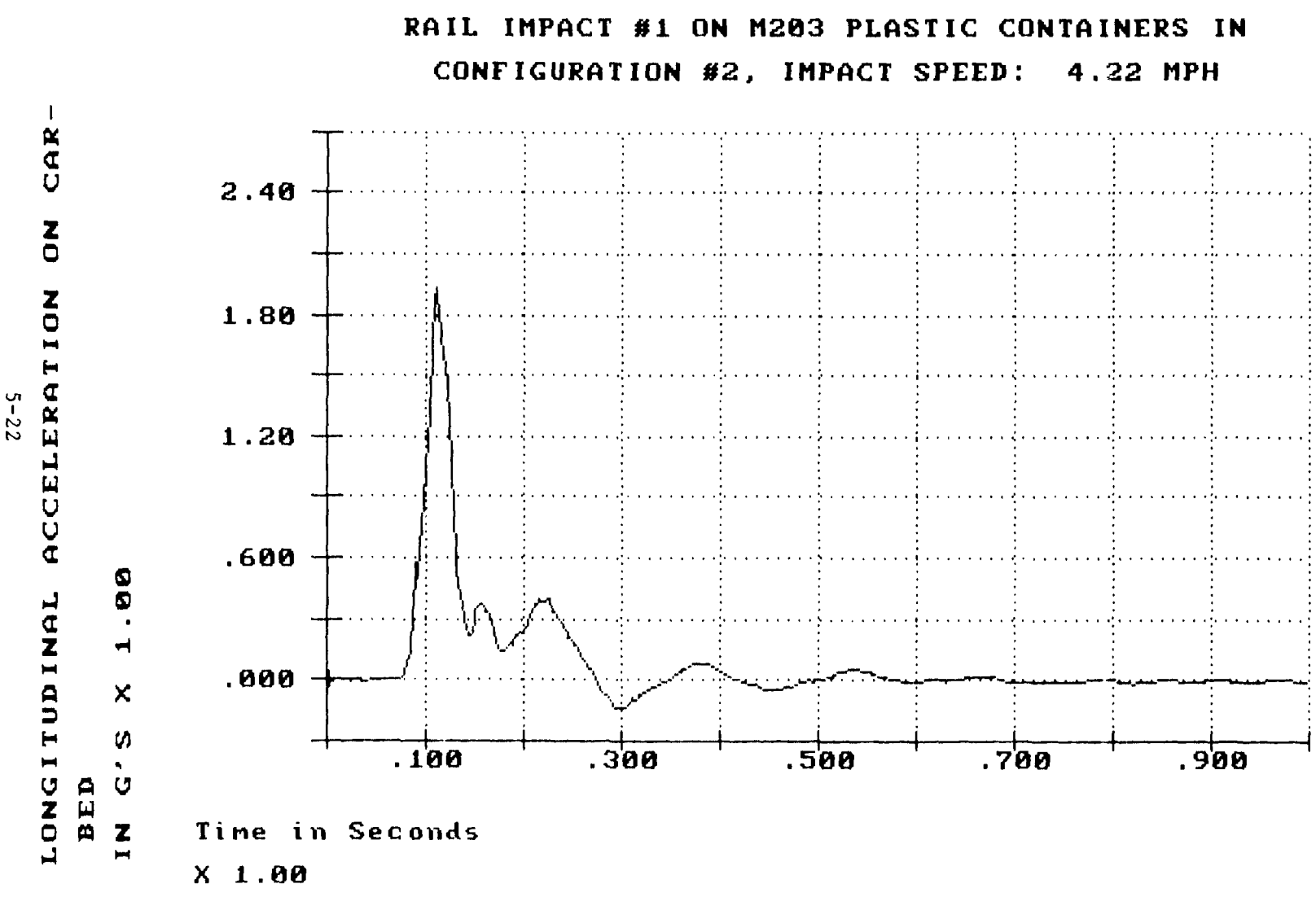
TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.22	-4.11	15.07	.0430
IMPACT 2	6.31	-6.18	42.30	.1197
IMPACT 3	8.47	-5.79	15.03	.0696
IMPACT 4 (REVERSE)	8.36	-4.97	29.01	.1023

TAPE CHANNEL 6 : VERTICAL ACCELERATION ON TOP LAYER PALLET

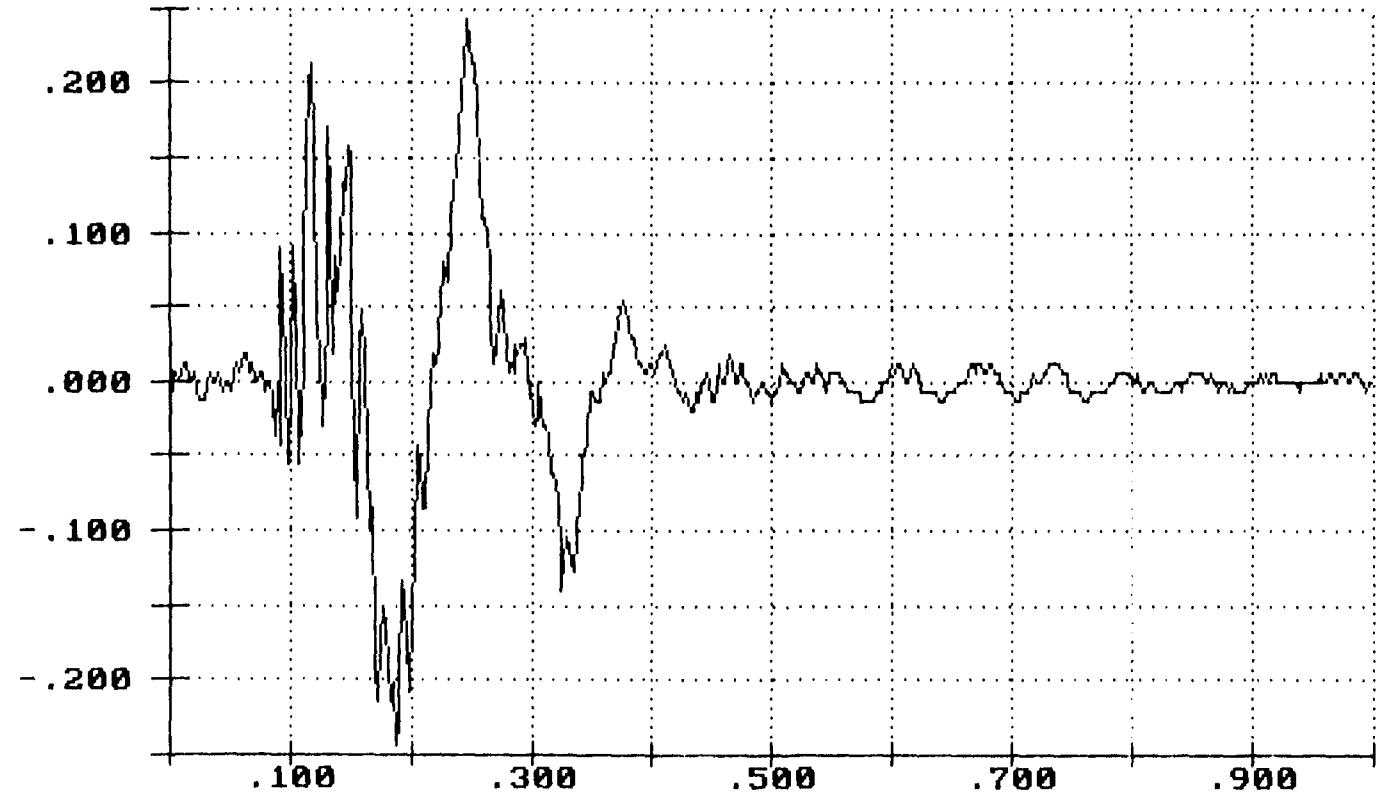
TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.22	-3.12	6.24	.0142
IMPACT 2	6.31	-6.36	14.13	.0640
IMPACT 3	8.47	-4.46	12.28	.0417
IMPACT 4 (REVERSE)	8.36	-4.71	11.86	.0413

TAPE CHANNEL 7 : LONGITUDINAL ACCELERATION ON CAR SILL

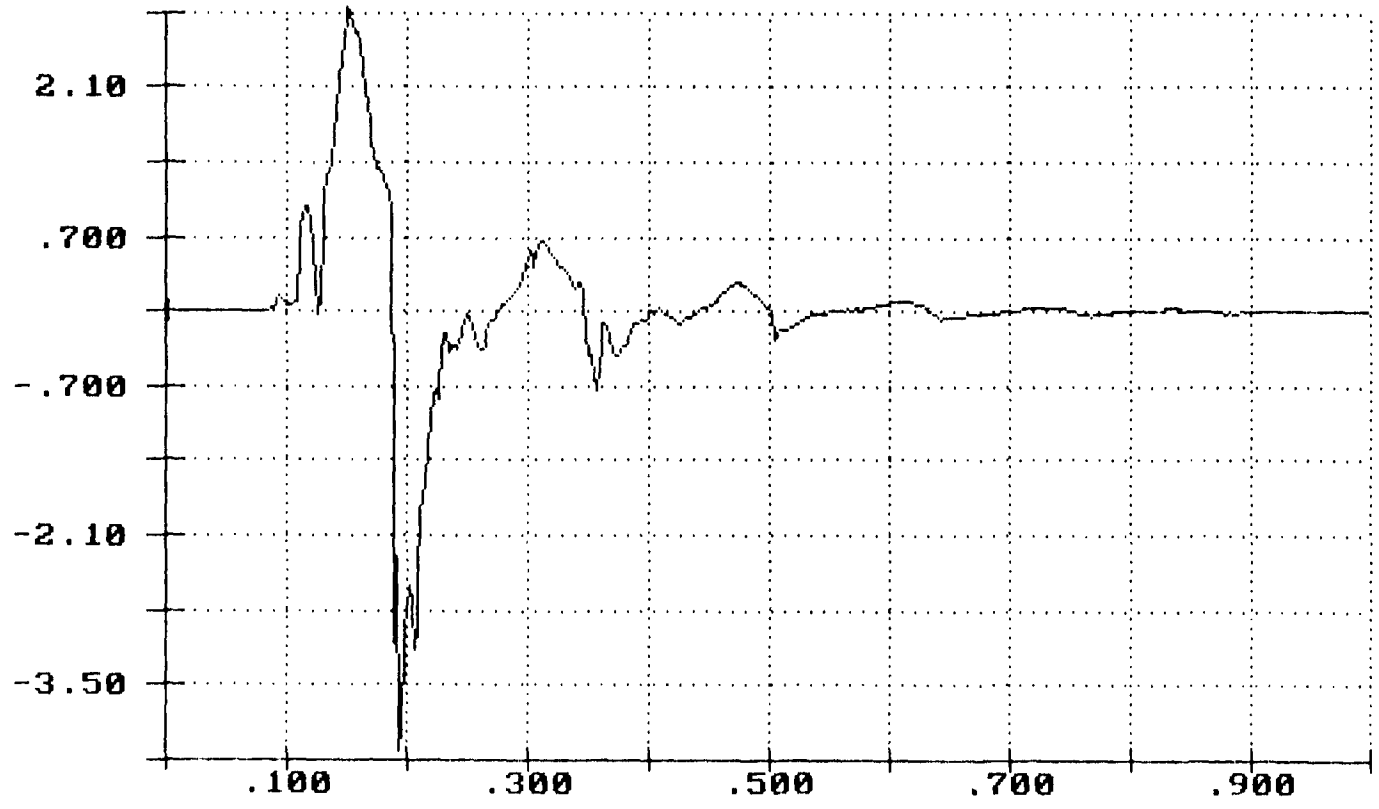
TEST	SPEED MPH	PEAK VALUE G'S	DURATION MILLISECONDS	AREA G'S-SECONDS
IMPACT 1	4.22	2.00	40.34	.0515
IMPACT 2	6.31	2.30	24.88	.0345
IMPACT 3	8.47	2.65	31.33	.0606
IMPACT 4 (REVERSE)	8.36	-3.16	31.78	.0653

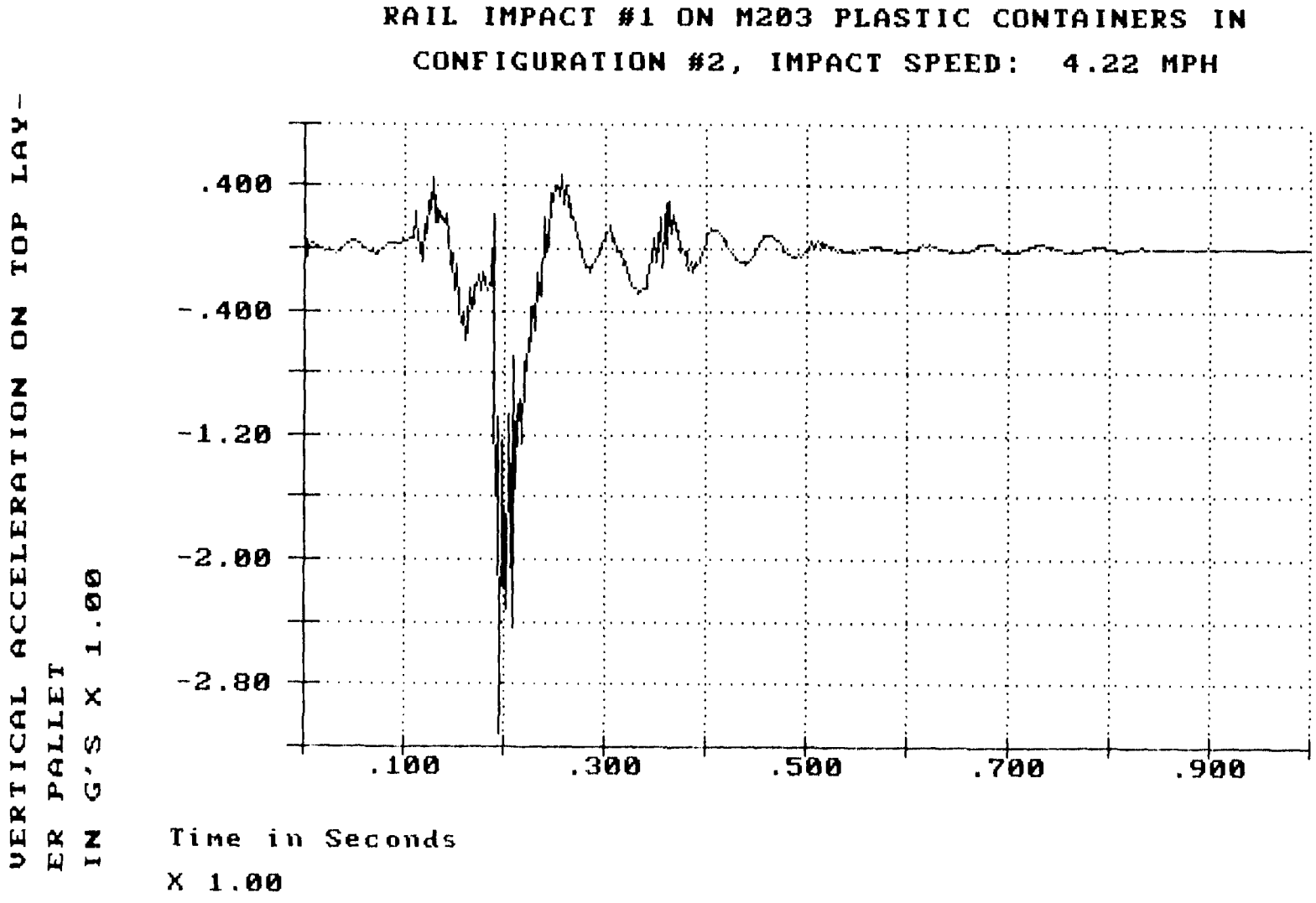

RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 4.22 MPH
LONGITUDINAL ACCELERATION ON CAR-
BED
IN G'S X 1.00
2.40
1.80
1.20
.600
.000
.100
.300
.500
.700
.900
Time in Seconds
X 1.00

RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 4.22 MPH

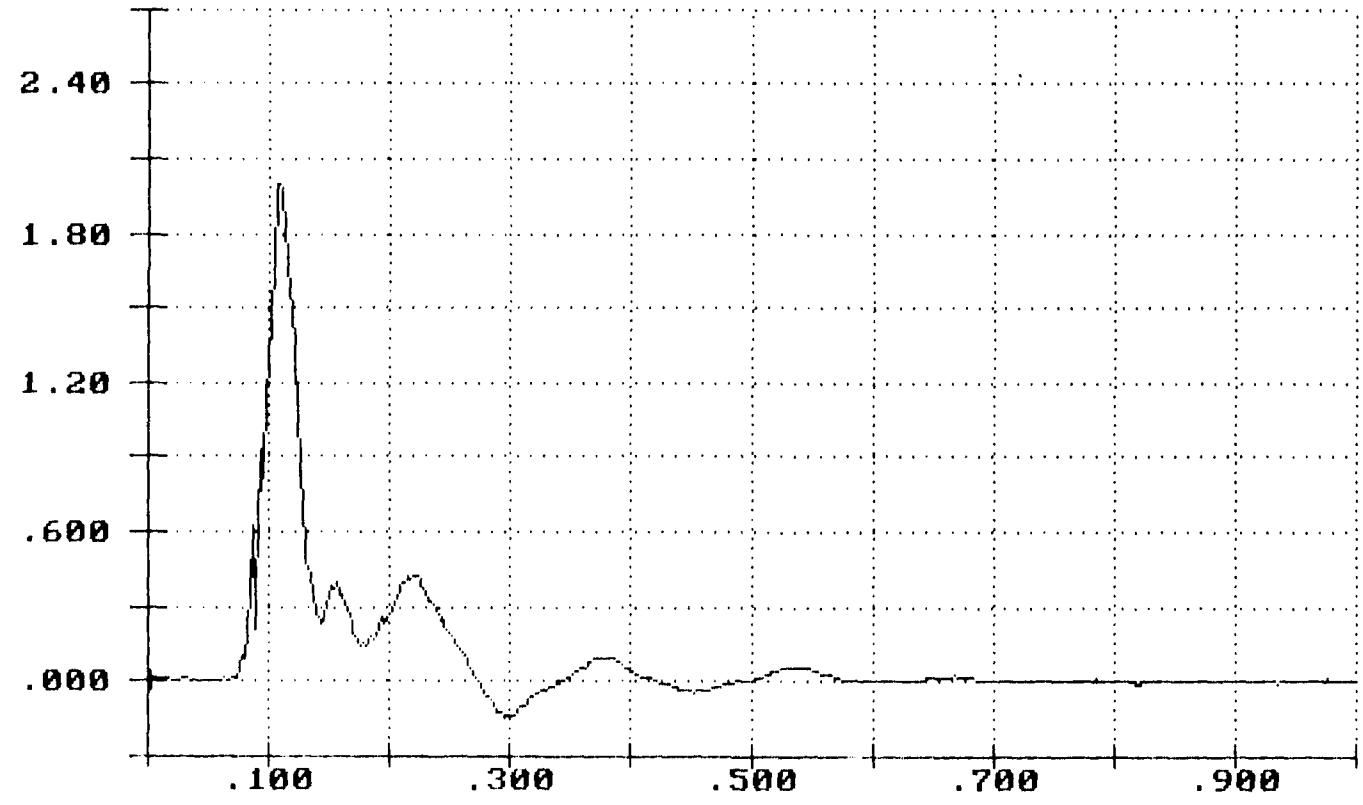


RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 4.22 MPH




RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 4.22 MPH
VERTICAL ACCELERATION ON TOP LAY-
ER PALLET
IN G'S X 1.00
.400
-.400
-1.20
-2.00
-2.80
.100
.300
.500
.700
.900
Time in Seconds
X 1.00

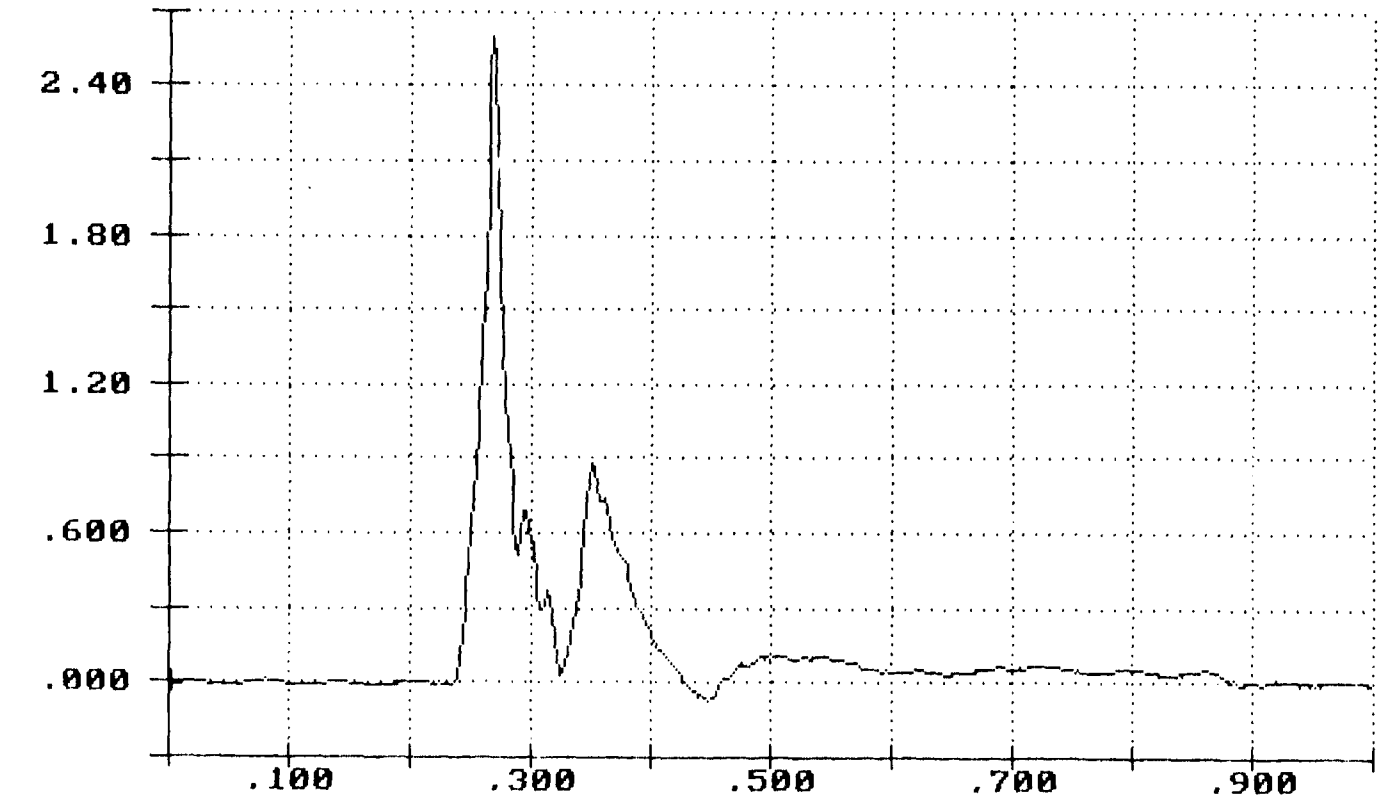
RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 4.22 MPH



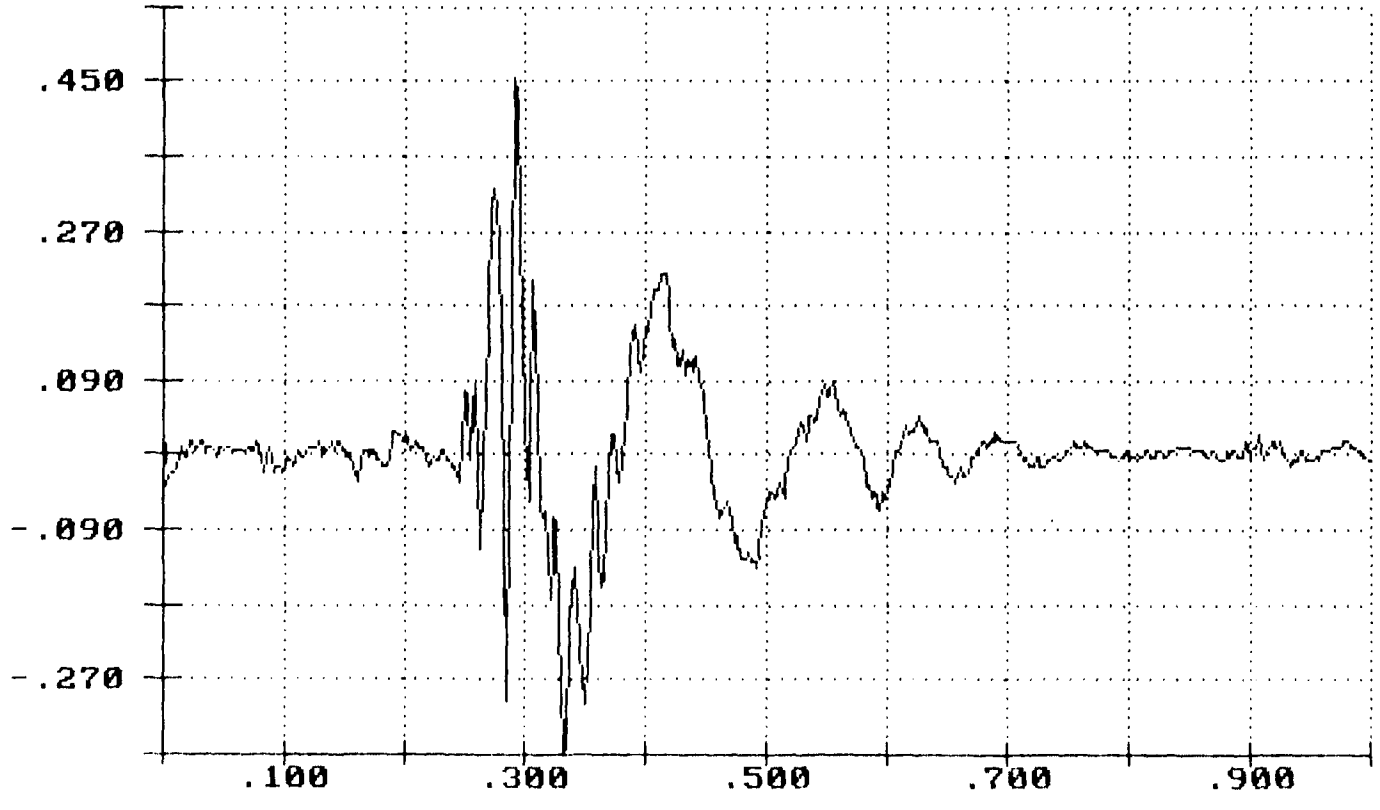
LONGITUDINAL ACCELERATION ON CAR-SILL IN G'S X 1.00

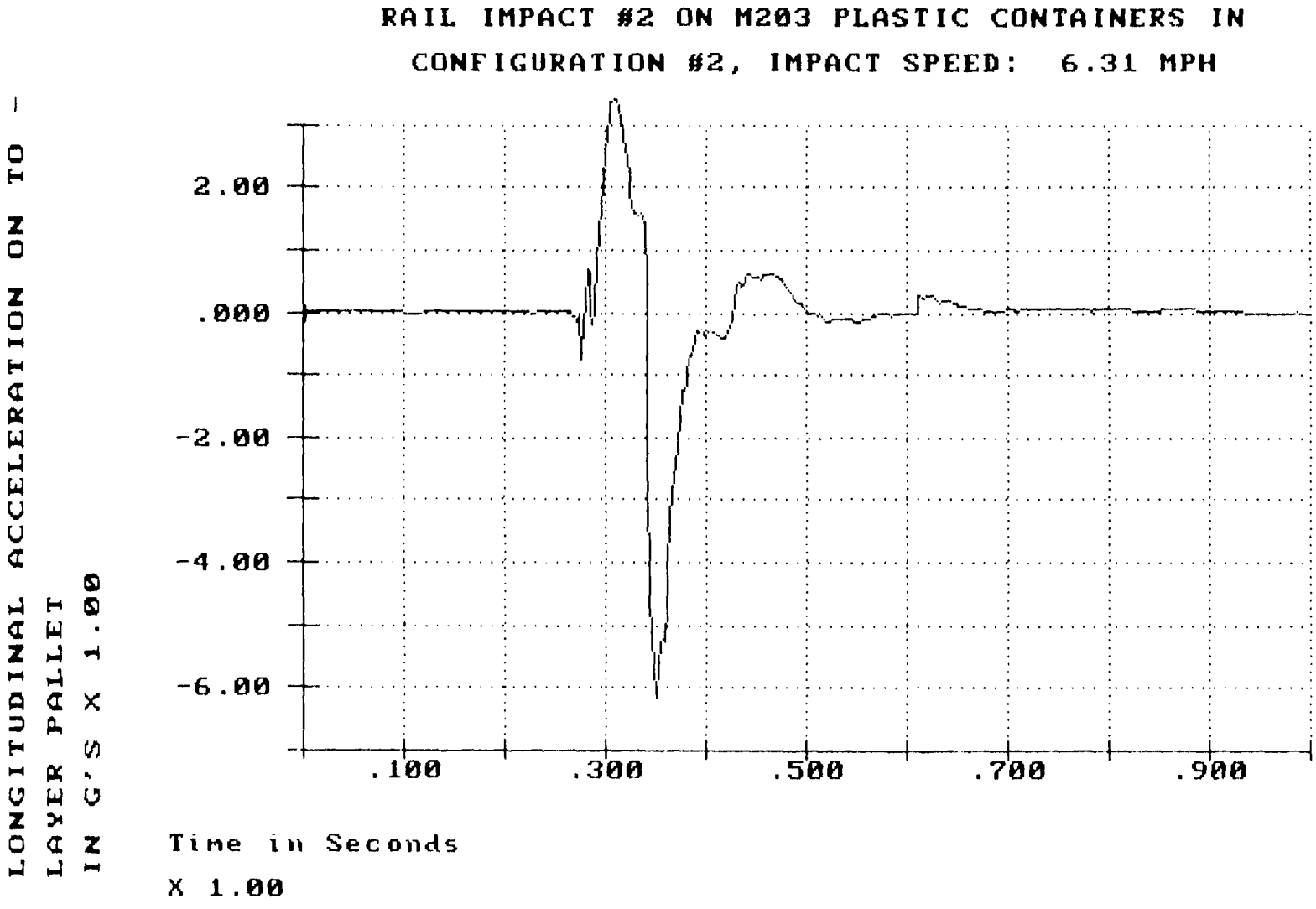
Time in Seconds
X 1.00

RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 6.31 MPH

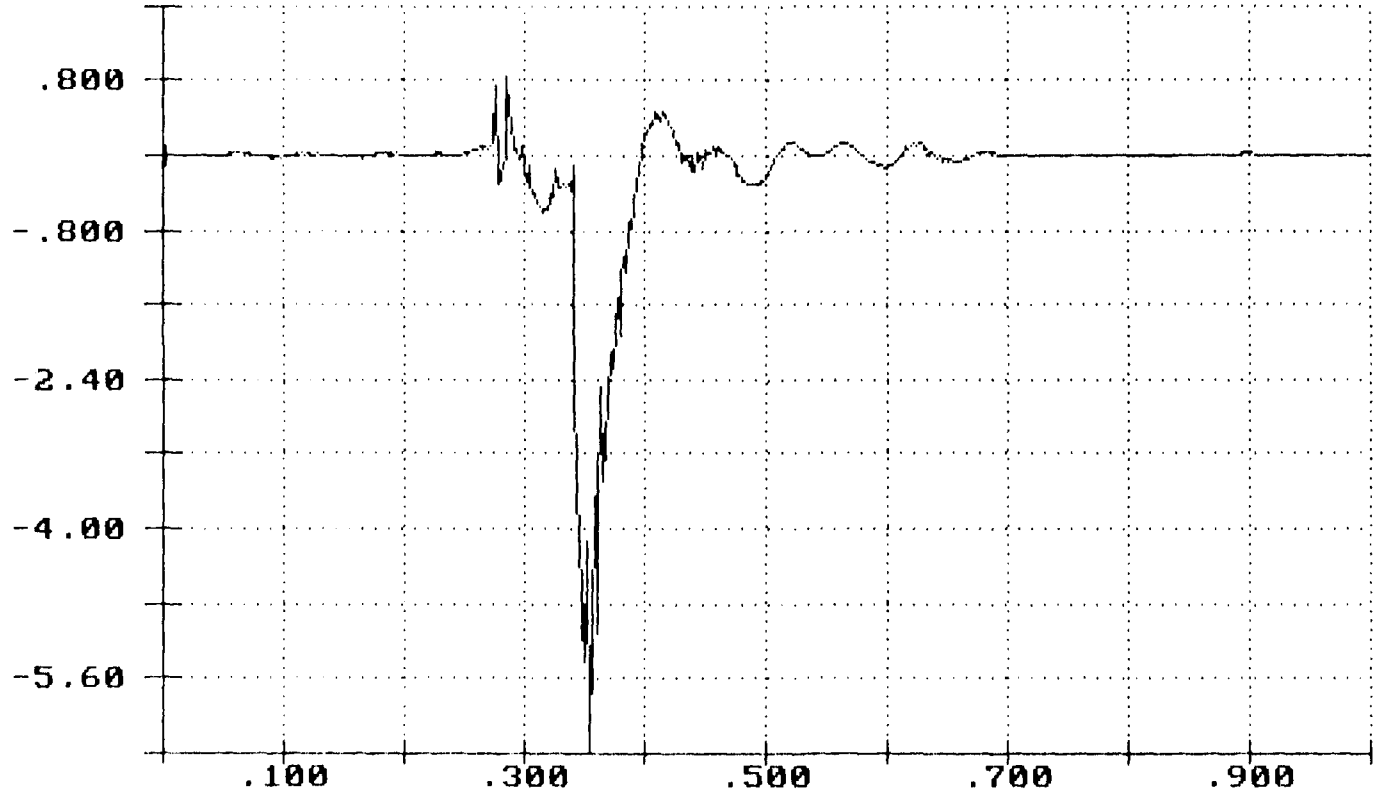


RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 6.31 MPH




RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 6.31 MPH
LONGITUDINAL ACCELERATION ON TO -
LAYER PALLET
IN G'S X 1.00
2.00
.000
-2.00
-4.00
-6.00
.100
.300
.500
.700
.900
Time in Seconds
X 1.00

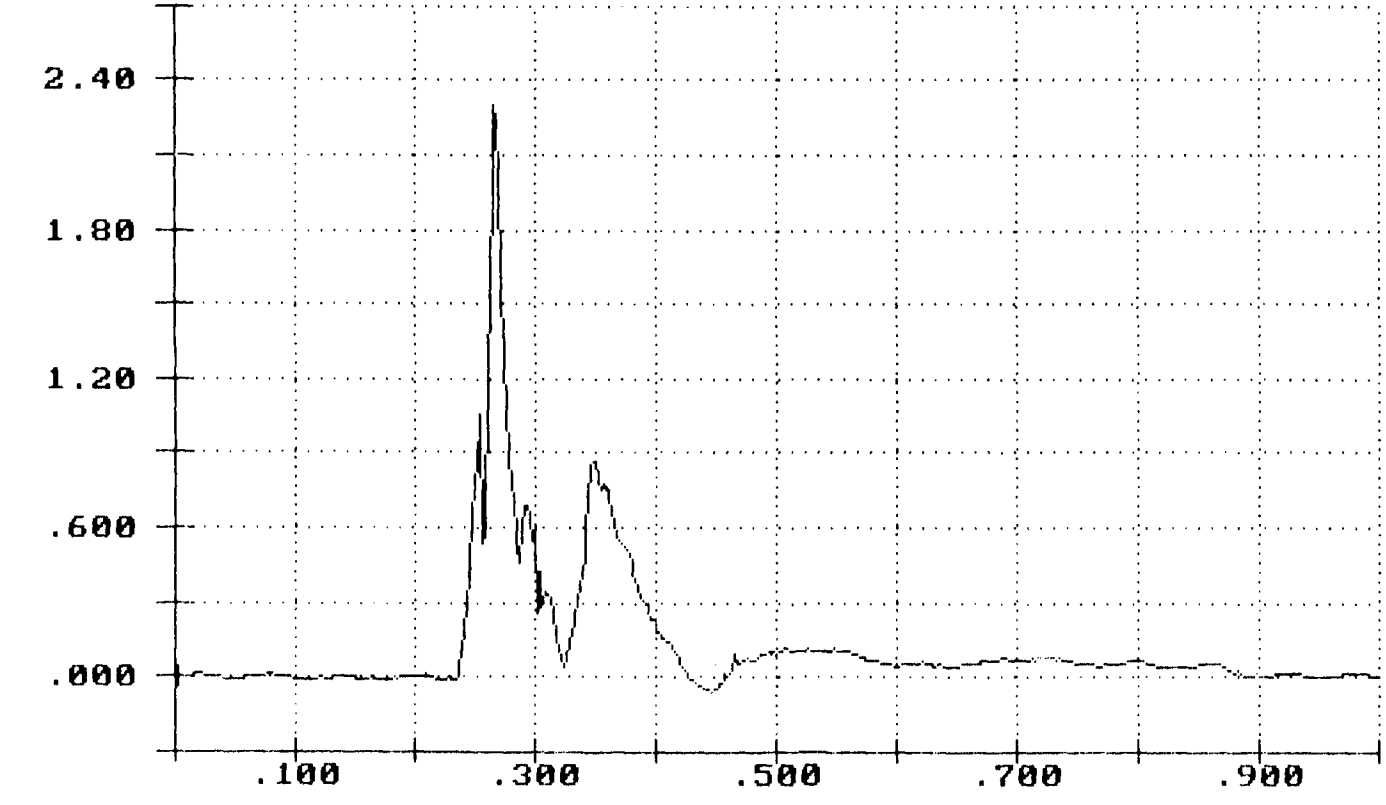
RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 6.31 MPH

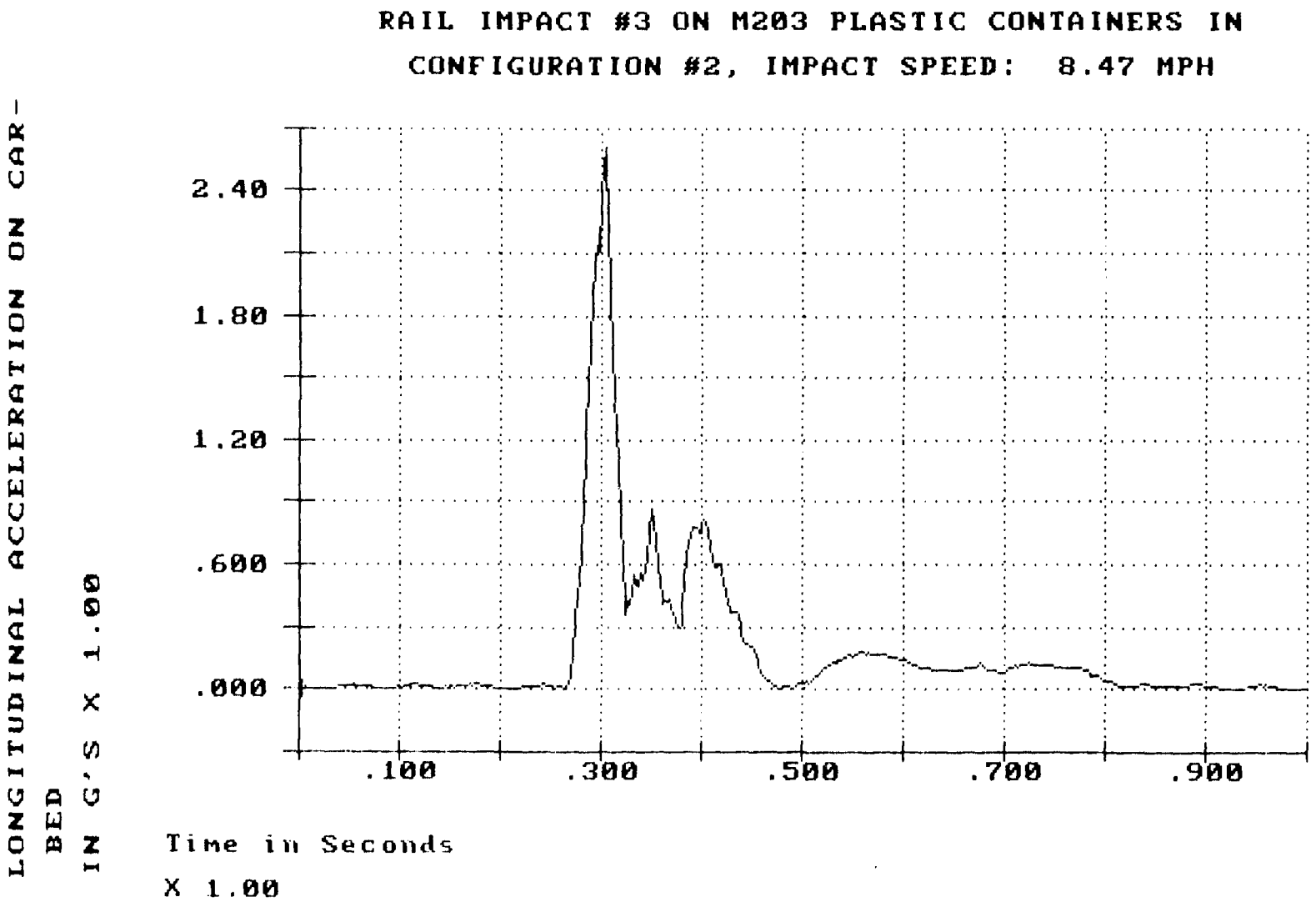


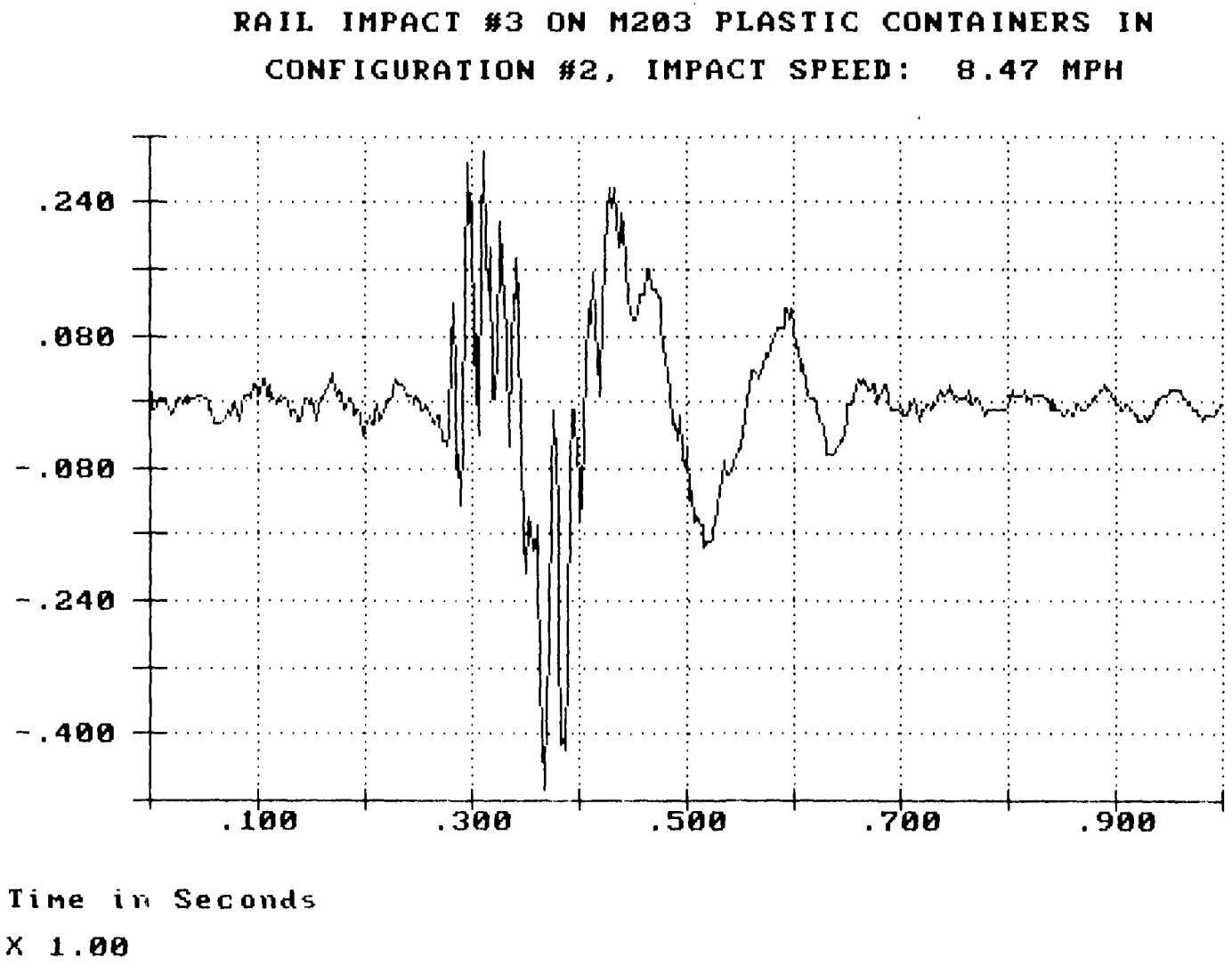
VERTICAL ACCELERATION ON TOP LAYER PALLET IN G'S X 1.00

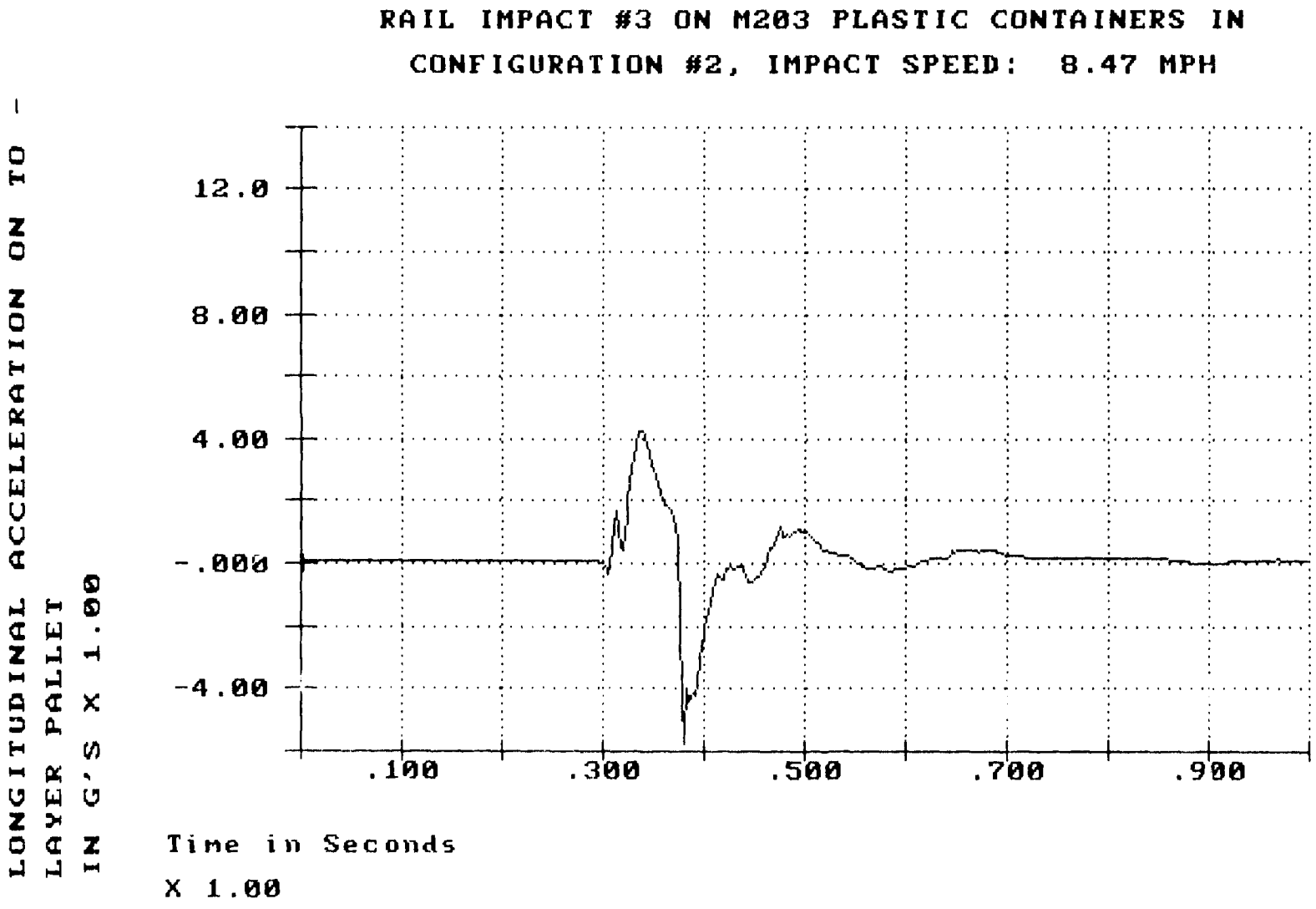
Time in Seconds
X 1.00

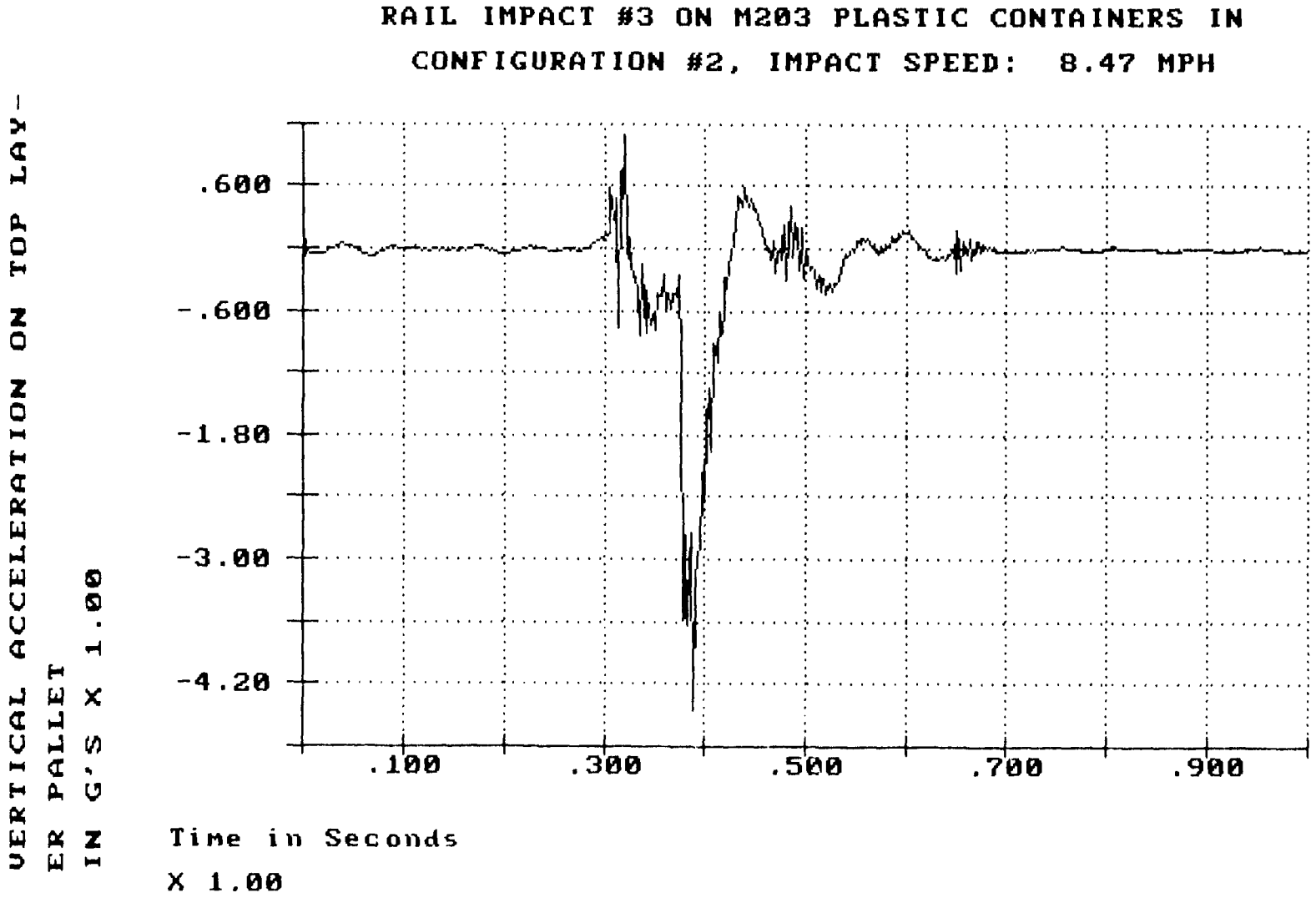
RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 6.31 MPH

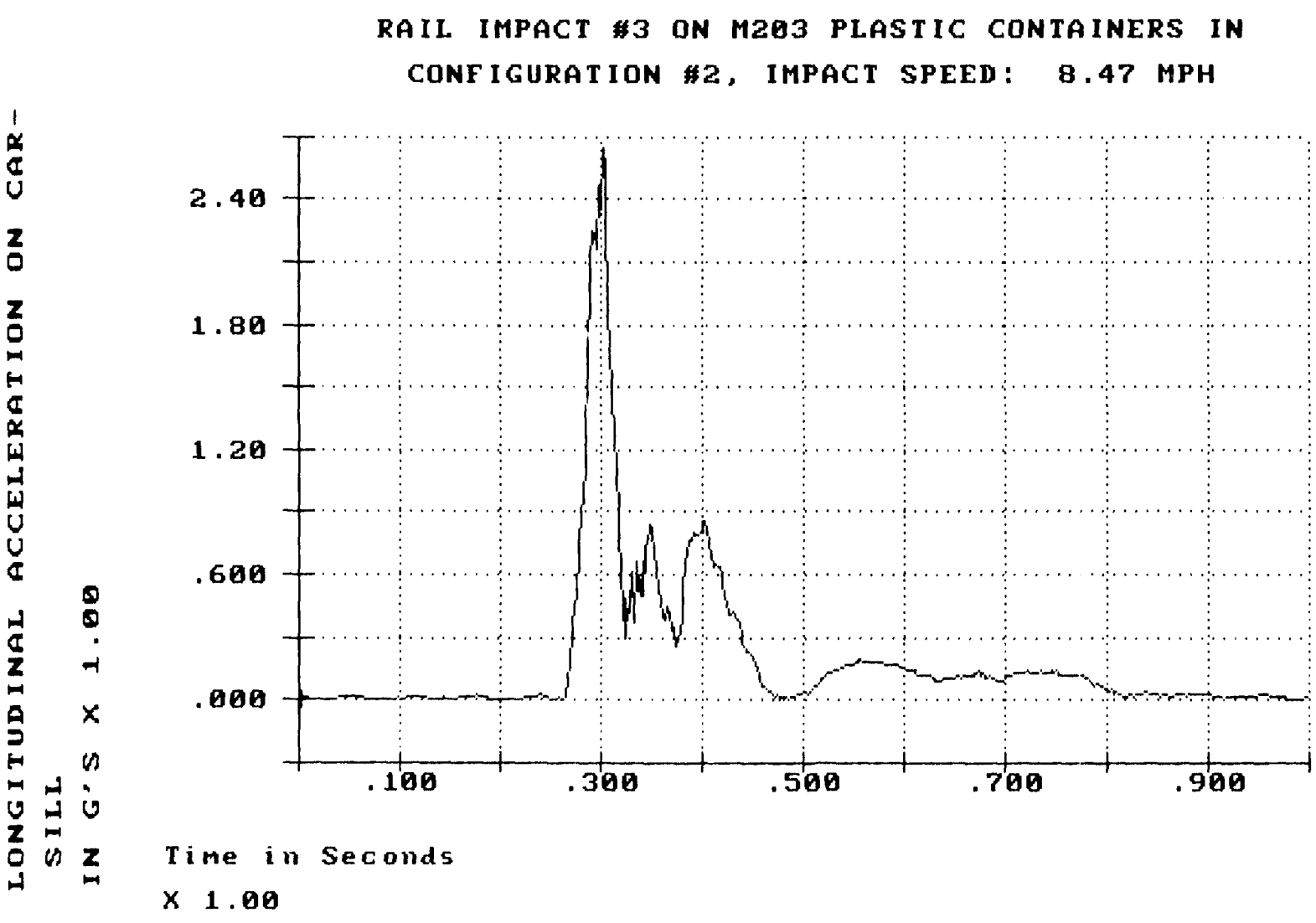



RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.47 MPH
LONGITUDINAL ACCELERATION ON CAR-BED IN G'S X 1.00
2.40
1.80
1.20
.600
.000
.100
.300
.500
.700
.900
Time in Seconds
X 1.00

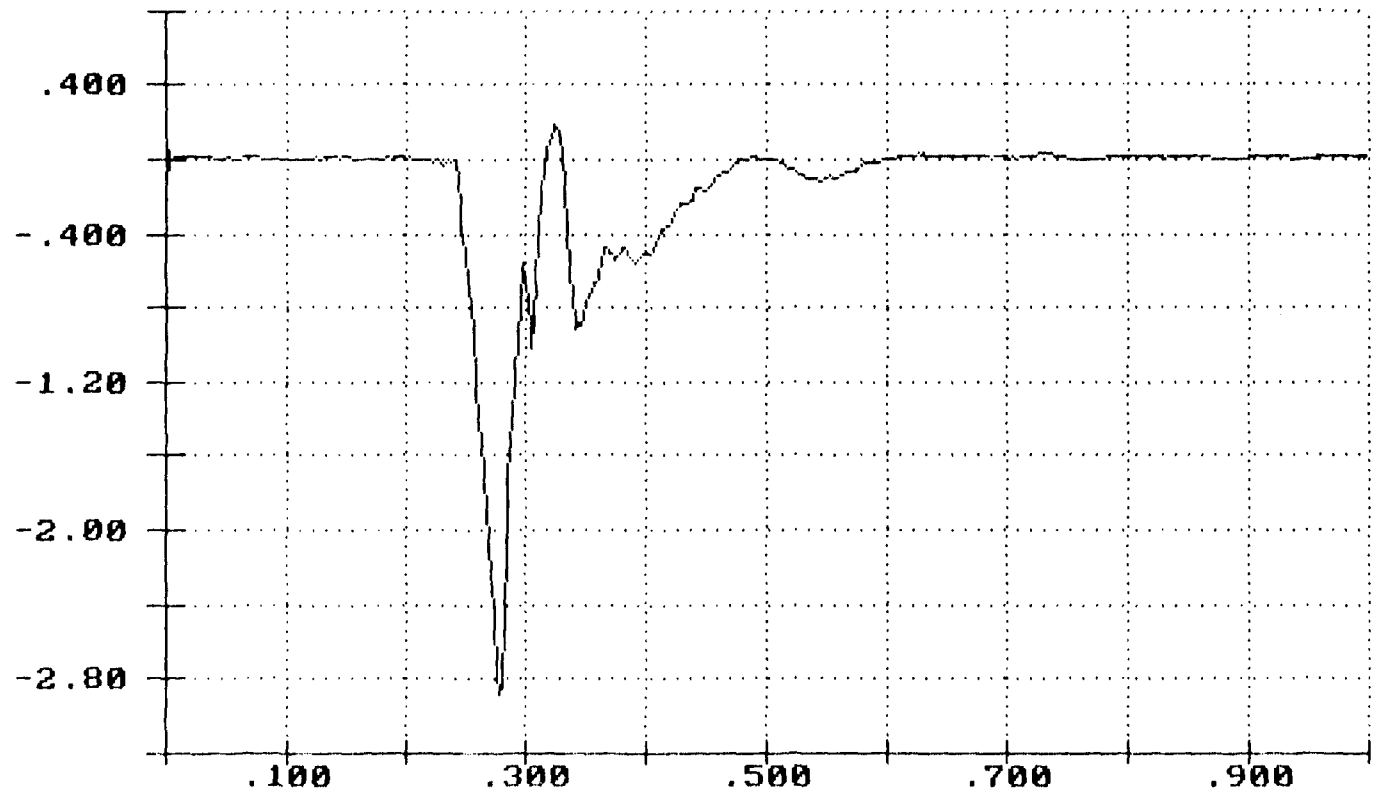

RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.47 MPH
VERTICAL ACCELERATION ON CAR BED
IN G'S X 1.00
.240
.080
-.080
-.240
-.400
.100
.300
.500
.700
.900
Time in Seconds
X 1.00


RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.47 MPH
LONGITUDINAL ACCELERATION ON TO -
LAYER PALLET
IN G'S X 1.00
12.0
8.00
4.00
-.000
-4.00
.100
.300
.500
.700
.900
Time in Seconds
X 1.00


RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.47 MPH
VERTICAL ACCELERATION ON TOP LAYER PALLET
IN G'S X 1.00
.600
-.600
-1.80
-3.00
-4.20
.100
.300
.500
.700
.900
Time in Seconds
X 1.00

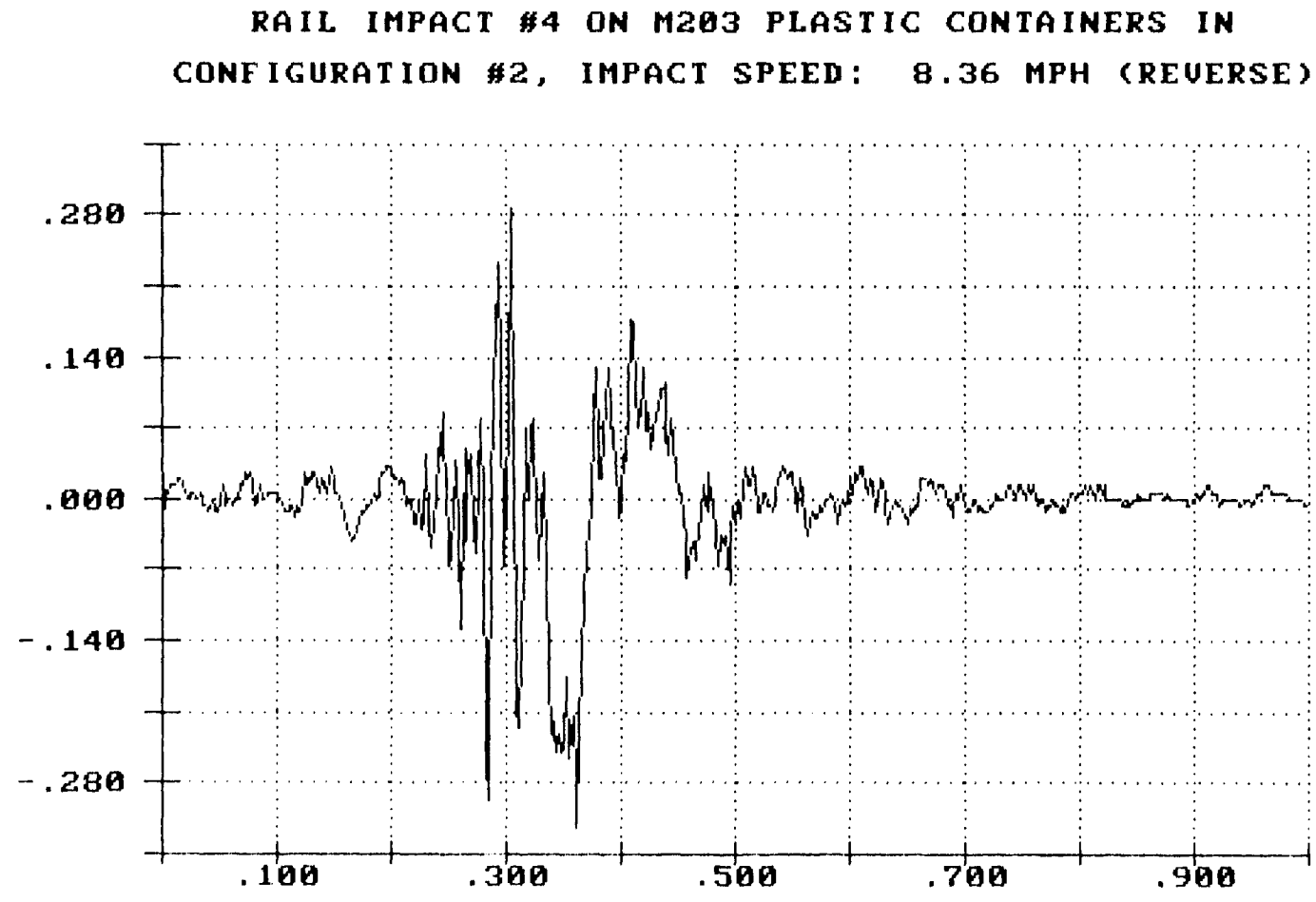

RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.47 MPH
LONGITUDINAL ACCELERATION ON CAR-
SILL
IN G'S X 1.00
2.40
1.80
1.20
.600
.000
.100
.300
.500
.700
.900
Time in Seconds
X 1.00

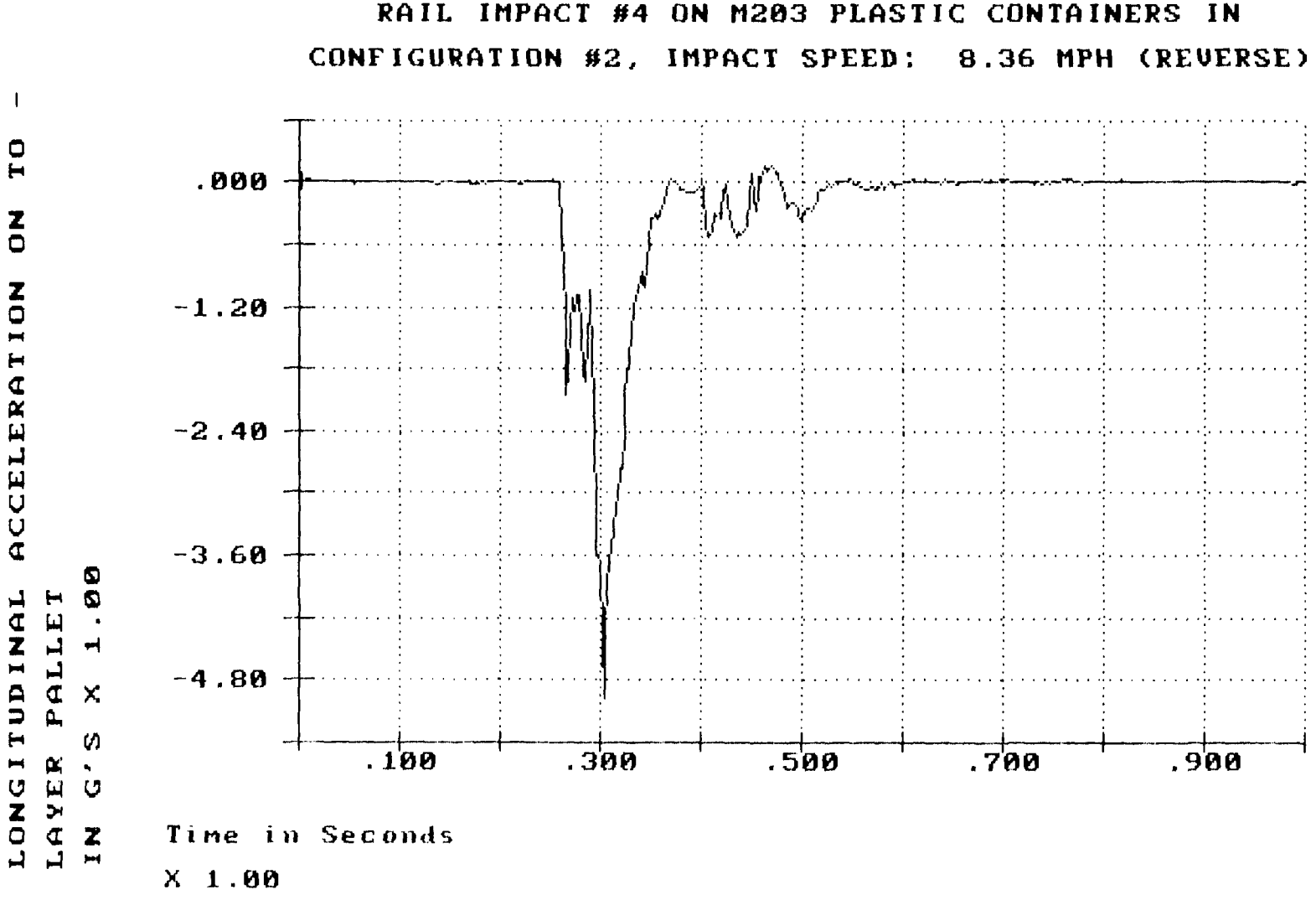
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)



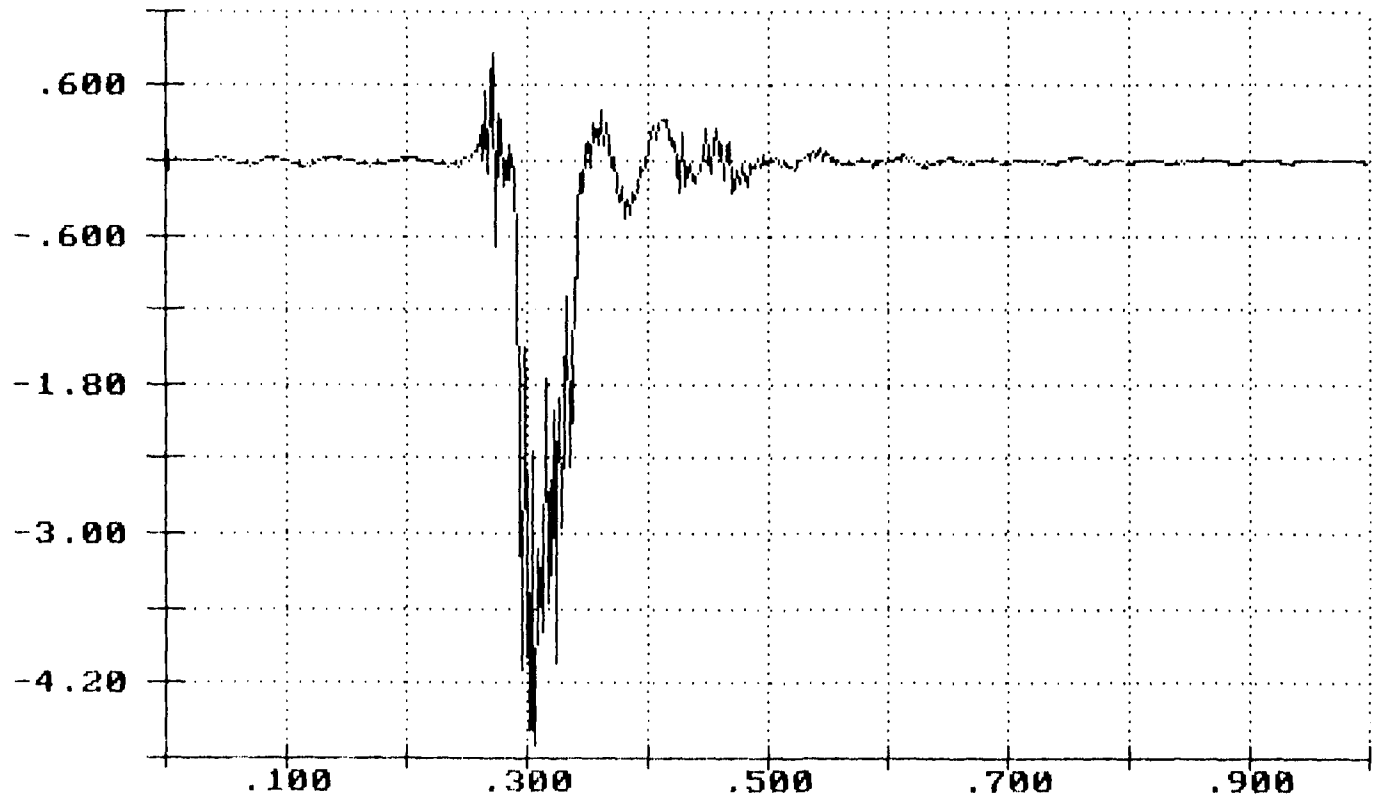
LONGITUDINAL ACCELERATION ON CAR-BED IN G'S X 1.00

Time in Seconds
X 1.00


RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)
VERTICAL ACCELERATION ON CAR BED
IN G'S X 1.00
.280
.140
.000
-.140
-.280
.100
.300
.500
.700
.900
Time in Seconds
X 1.00


RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)
LONGITUDINAL ACCELERATION ON TO - LAYER PALLET IN G'S X 1.00
.000
-1.20
-2.40
-3.60
-4.80
.100
.300
.500
.700
.900
Time in Seconds
X 1.00

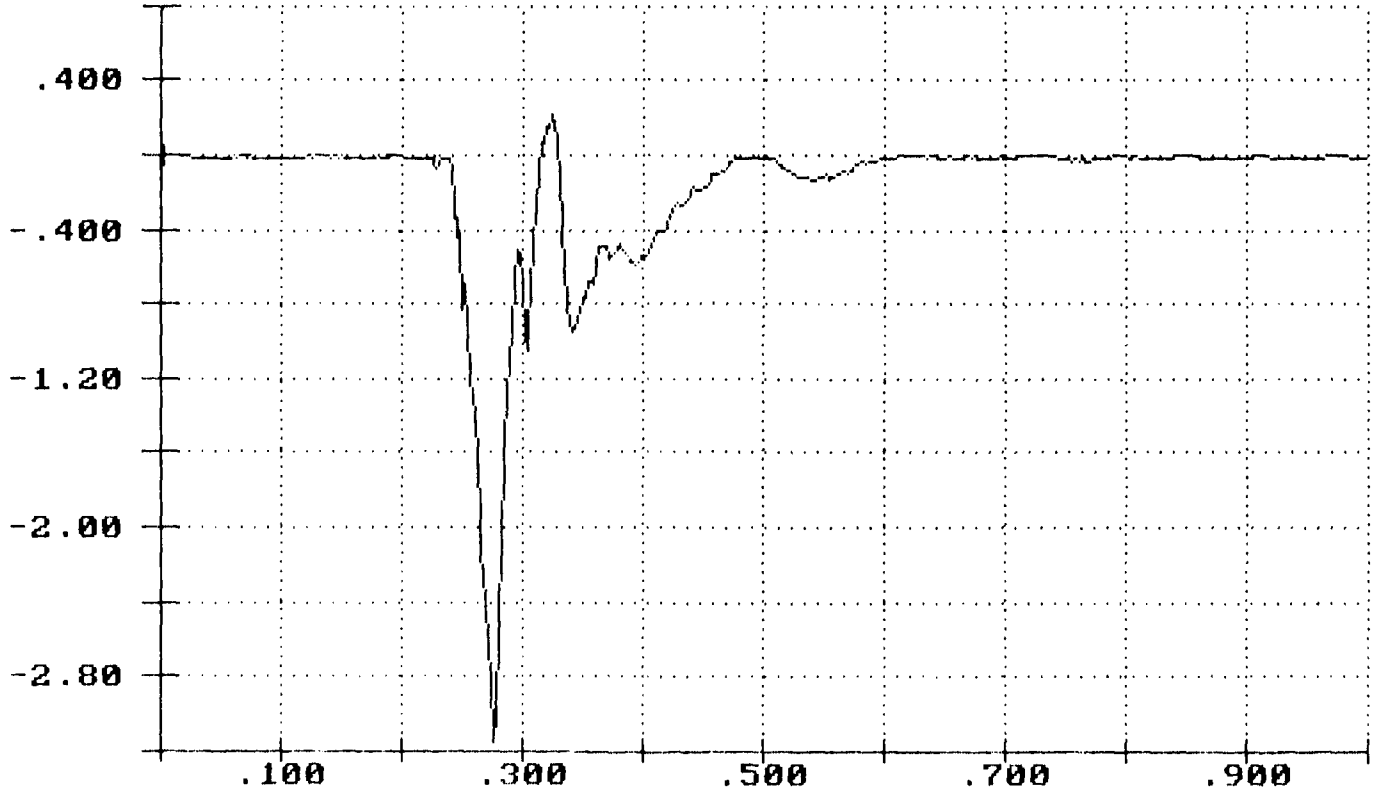
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)



VERTICAL ACCELERATION ON TOP LAYER PALLET IN G'S X 1.00

Time in Seconds
X 1.00

RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)



LONGITUDINAL ACCELERATION ON CAR-SILL IN G'S X 1.00

Time in Seconds
X 1.00

PART 6

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS. At the conclusion of these tests, it was found that the only damage to the M203 155mm Propelling Charge Plastic Containers on Metal Pallets was a slight shuffling of the container ends when tested in the longitudinal orientation. No damage was observed when tested in the lateral orientation. Test loads shifted approximately six inches during the longitudinal orientation due to failure of the load filler pallets. Shift of the lateral load configuration was three inches. Two of the upper layer pallets became disengaged from the stacking lugs at the third and fourth impacts. One skid was deformed at the stacking lug entry point. The deformation was not enough to warrant rejection of test specimen.

B. RECOMMENDATIONS. Based on these tests, it is recommended that the propelling charge plastic container unitized on metal pallets can be transported by rail inside a boxcar. Modifications to the unitization procedure should be made to the center gates limiting the spacer width to the frontal surface of the unit.

PART 7

BLOCKING AND BRACING PROCEDURE

BOXCAR TRANSPORTABILTIY TEST PROCEDURES FOR PLASTIC PROPELLING CHARGE CONTAINERS ON METAL PALLET

This 15-Sheet document depicts the plastic propelling charge container unitized 36 on a metal pallet loaded into a 50'-6" long boxcar for impact testing purposes. PA116 containers loaded on a metal pallet are used as fillers in one load. Sheet 3 depicts the pallets loaded so that the 47" dimension is across the car. Sheet 5 depicts the pallets loaded so that the 36-7/8" dimension is across the car.

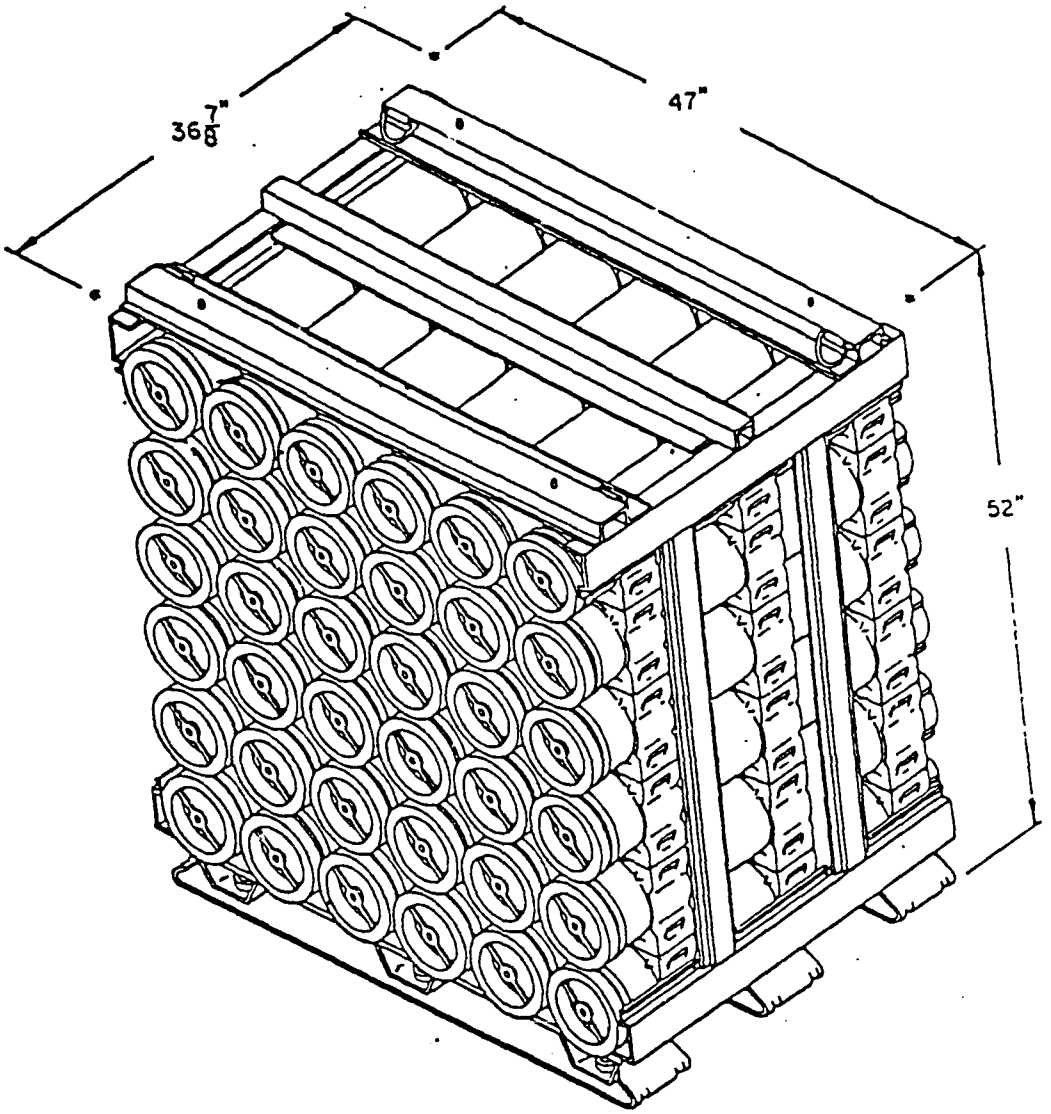
MATERIAL SPECIFICATIONS

LUMBER----------: See TM 743-200-1, dunnage lumber, Fed Spec MM-L-751.

NAILS----------: Common, Fed Spec FF-N-105.

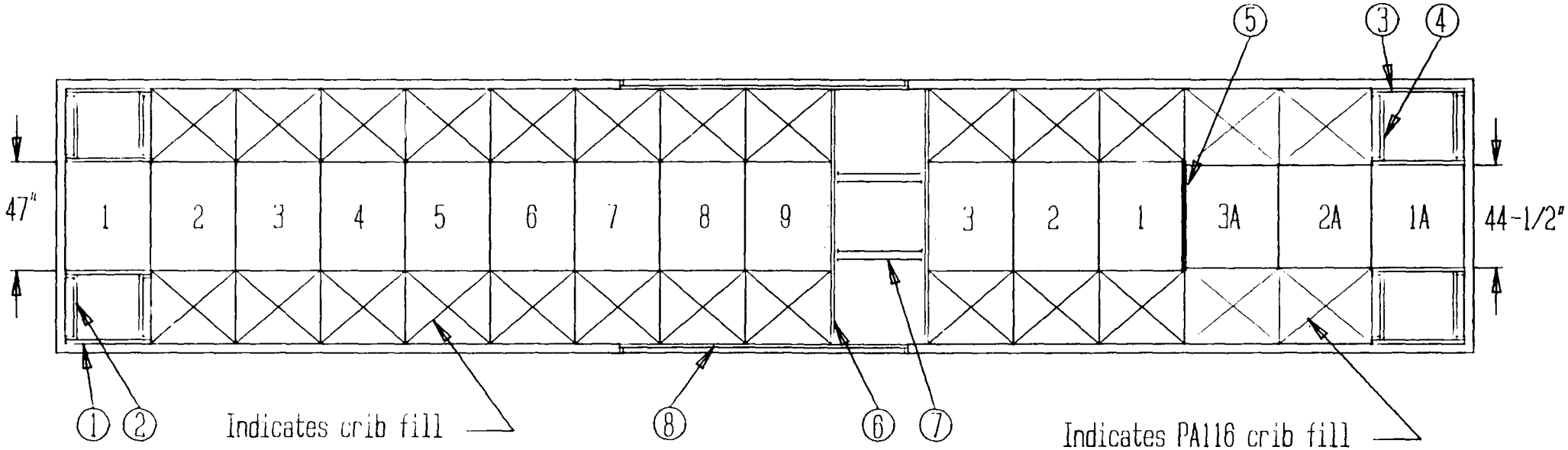
Prepared during December 1988 by:

U.S. Army Defense Ammunition Center
and School
ATTN: SMCAC-DEO
Savanna, IL 61074-9639



PALLET UNIT

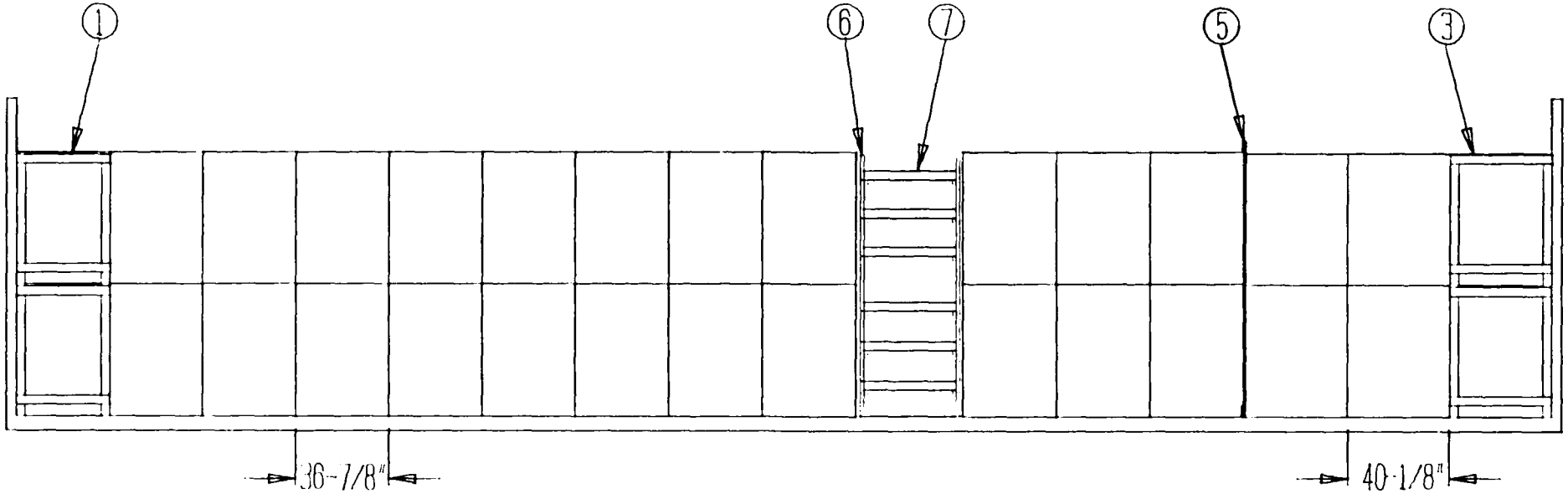
Container----------36 each @45 lbs (approx)
Cube----------52.2 cubic feet (approx)
Gross Weight----------1,786 lbs (approx)



PLAN VIEW

50'-6" long by 9'-2" wide boxcar

Note: Pallet units 1A thru 3A are PA116 pallets



ELEVATION VIEW

KEY NUMBERS
(For longitudinal load)

(1) Crib fill gate, 36-7/8" long (48 reqd). See the "Crib Fill Gate" detail on Sheet 7. Note that the four gates adjacent to the Separator Gate must be 37-5/8" long instead of 36-7/8".

(2) Strut, 2" x 4" by cut-to-fit (Ref: 28-1/2") (192 reqd). Nail to the vertical pieces of the Crib Fill Gates w/2-10d nails at each end.

(3) Crib fill gate, 40-1/8" long (12 reqd). See the "PA116 Pallet Crib Fill Gate" detail on Sheet 8.

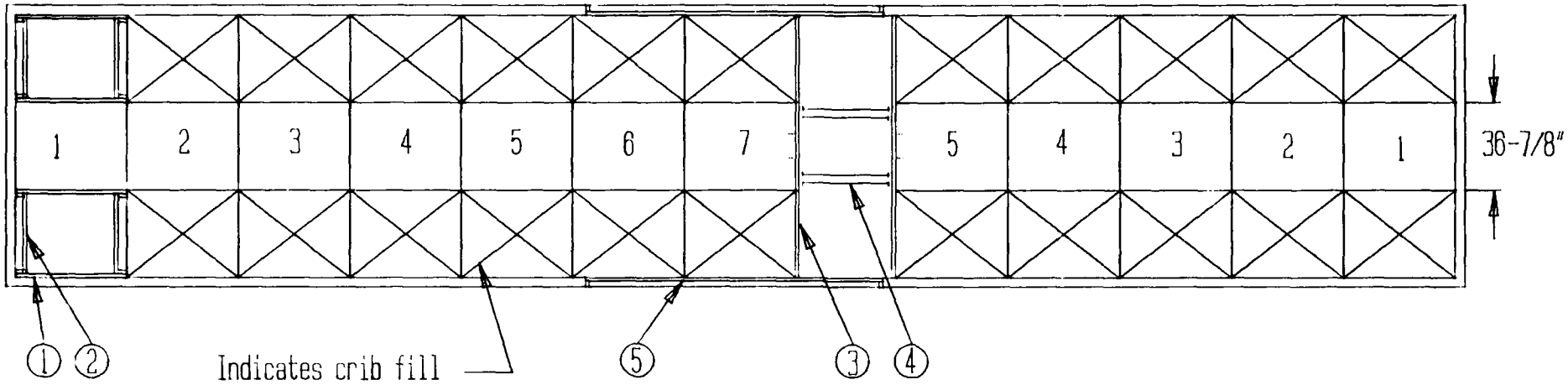
(4) Strut, 2" x 4" by cut-to-fit (Ref: 29-3/4") (48 reqd). Nail to the vertical pieces of the Crib Fill Gates w/2-10d nails at each end.

(5) Separator gate (1 reqd). See the "Separator Gate" detail on Sheet 9.

(6) Center gate (2 reqd). See the "Center Gate A" details on Sheets 10 and 11.

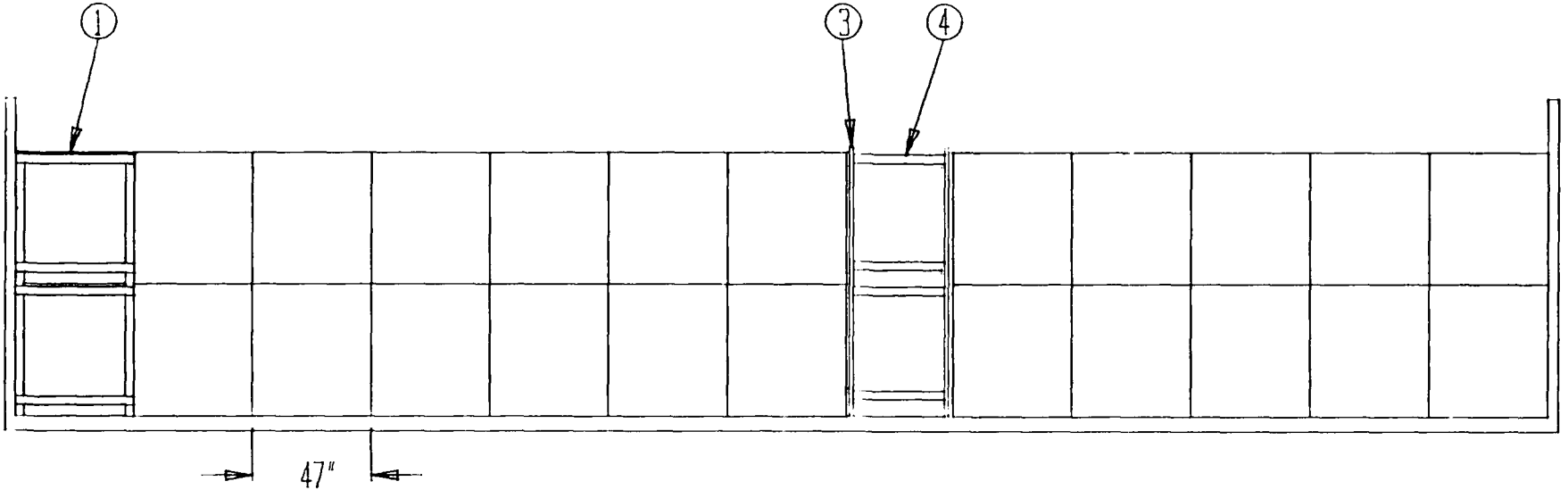
(7) Strut, 4" x 4" by cut-to-fit (Ref: 36-1/2") (12 reqd). Toenail to piece marked (6) w/2-16d nails at each joint.

(8) Doorway protection (2 reqd). See the "Doorway Protection" detail on Sheet 14. Nail to the door posts w/12d nails.



PLAN VIEW

50'-6" long by 9'-2" wide boxcar



ELEVATION VIEW

KEY NUMBERS
(For crosswise load)

(1) Crib fill gate, 47" long (48 reqd). See the "Crib Fill Gate" detail on Sheet 7.

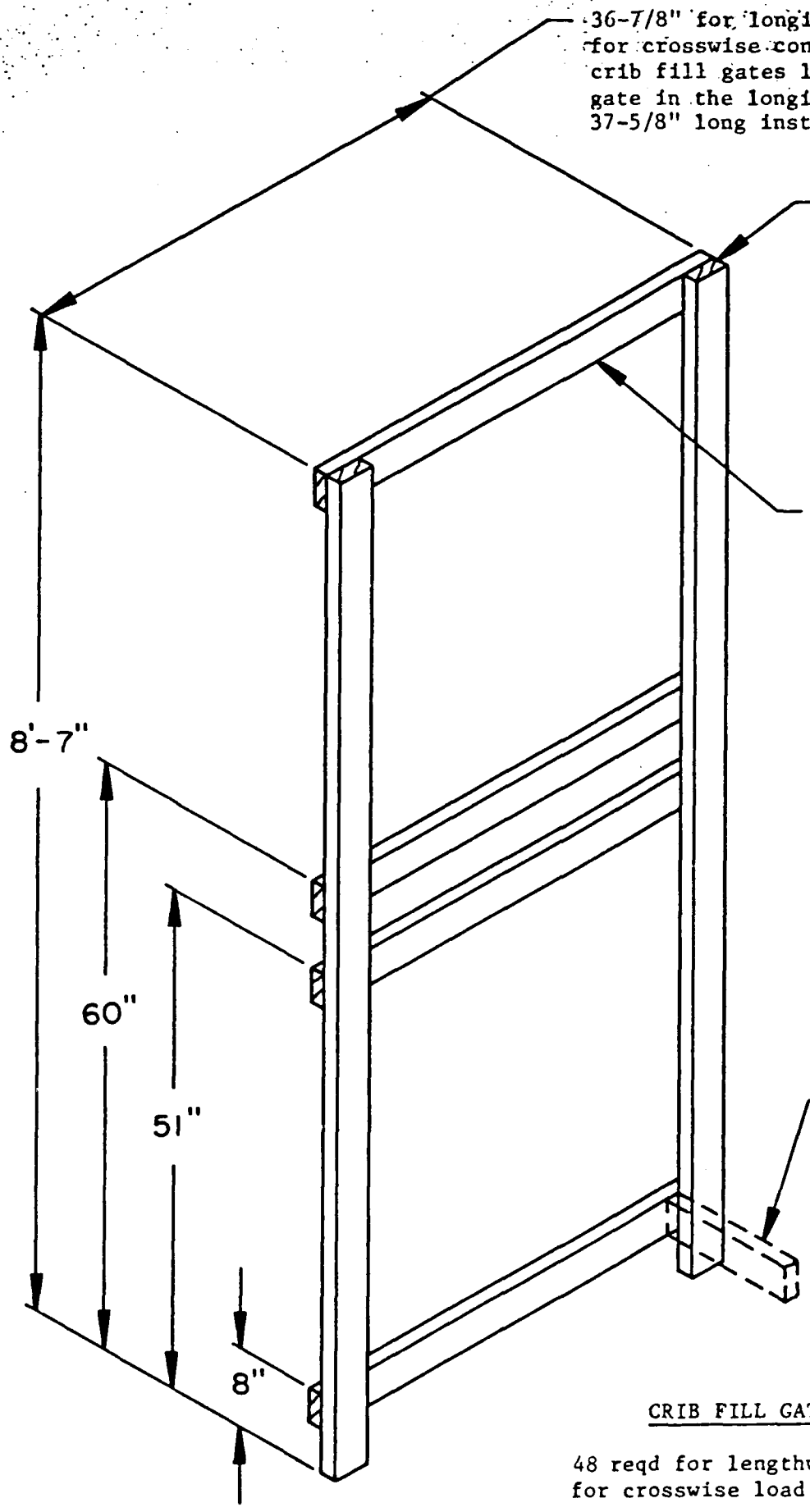
(2) Strut, 2" x 4" by cut-to-fit (Ref: 33-5/8") (192 reqd). Nail to the vertical pieces of the Crib Fill Gates w/2-10d nails at each end.

(3) Center gate (2 reqd). See the "Center Gate B" details on Sheets 12 and 13.

(4) Strut, 4" x 4" by cut-to-fit (Ref: 36") (8 reqd). Toenail to piece marked (6) w/2-16d nails at each joint.

(5) Doorway protection (2 reqd). See the "Doorway Protection" detail on Sheet 14. Nail to the door posts w/12d nails.

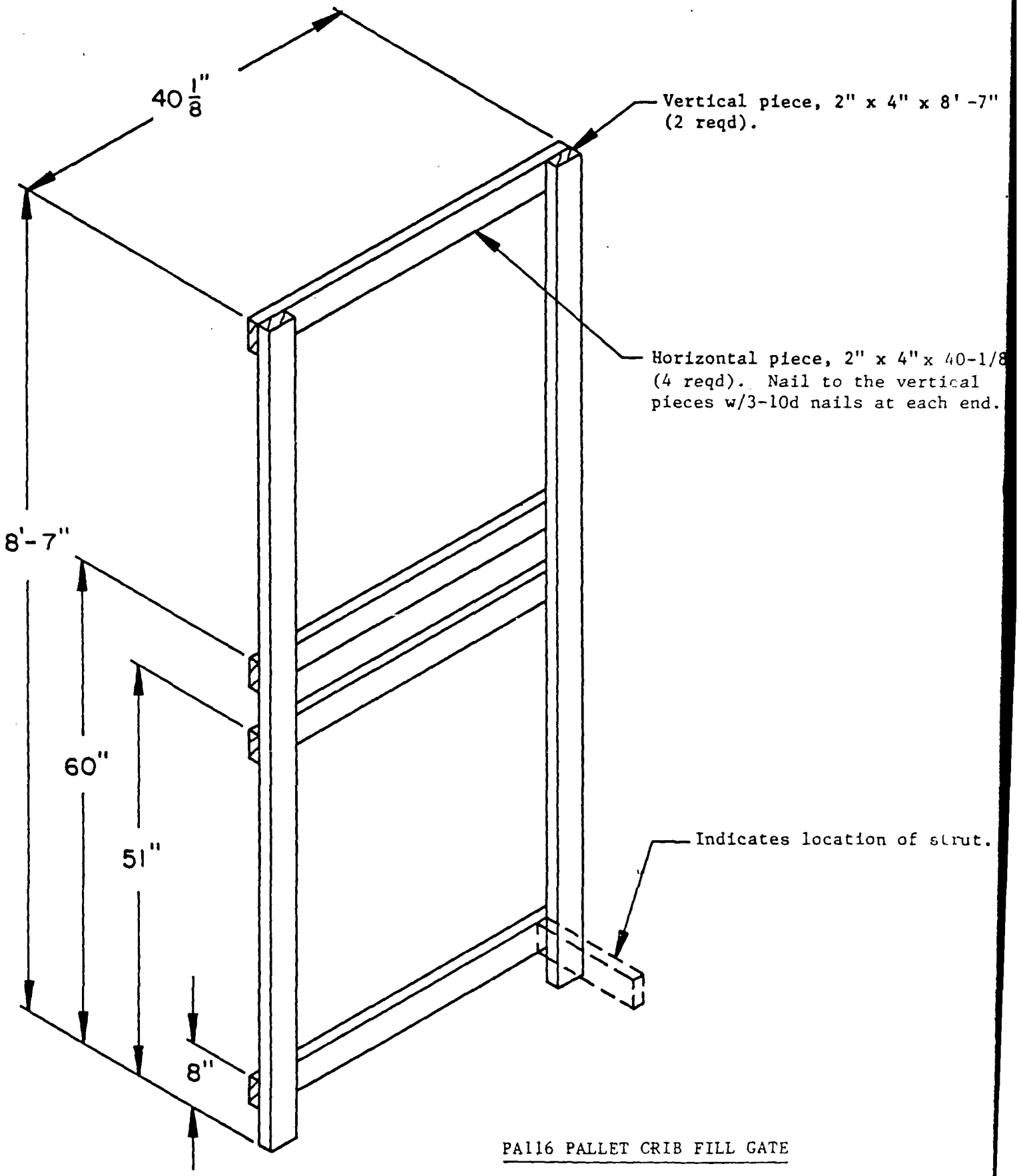
SHEET 6



CRIB FILL GATE

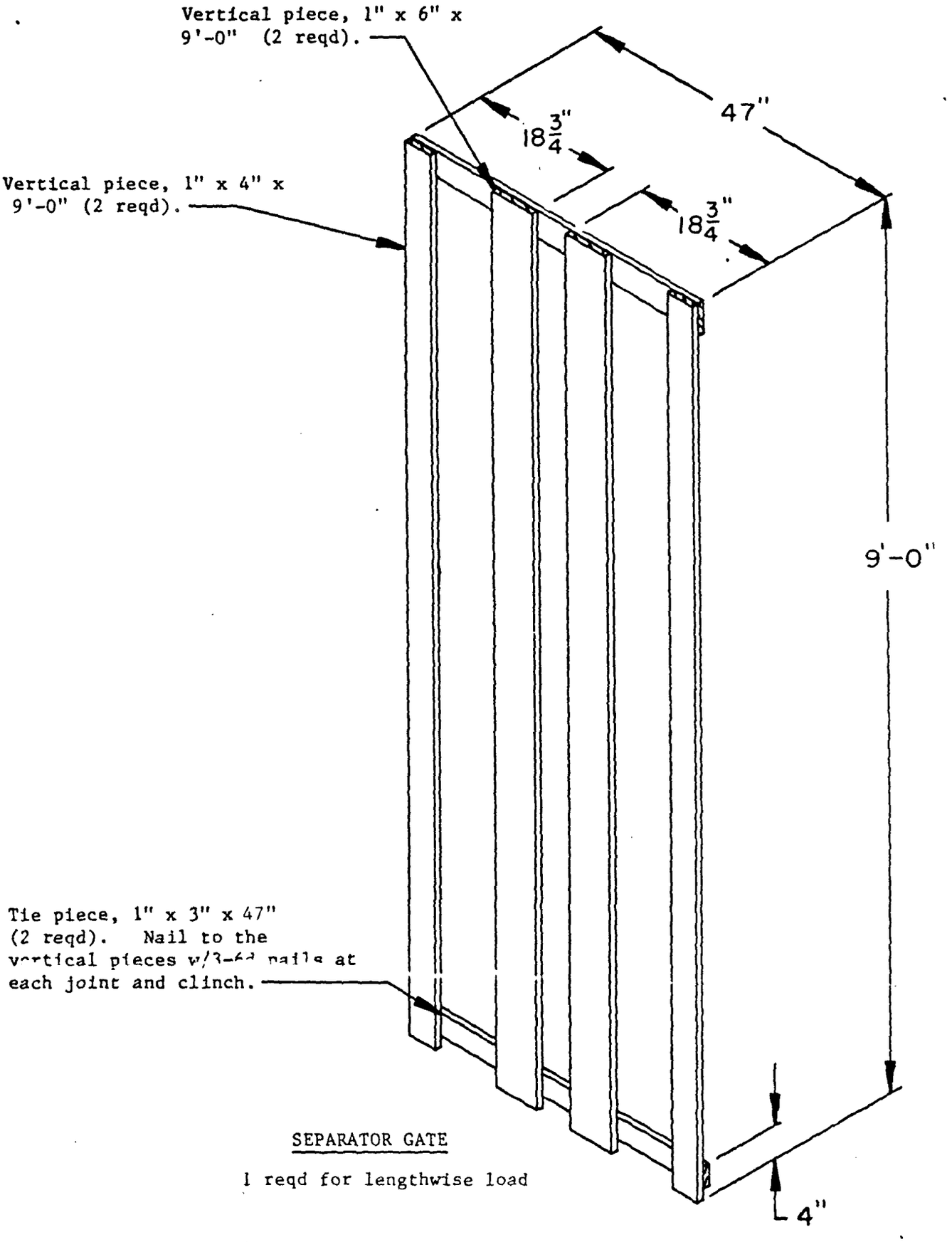
48 reqd for lengthwise load; 48 reqd for crosswise load.

SHEET 7



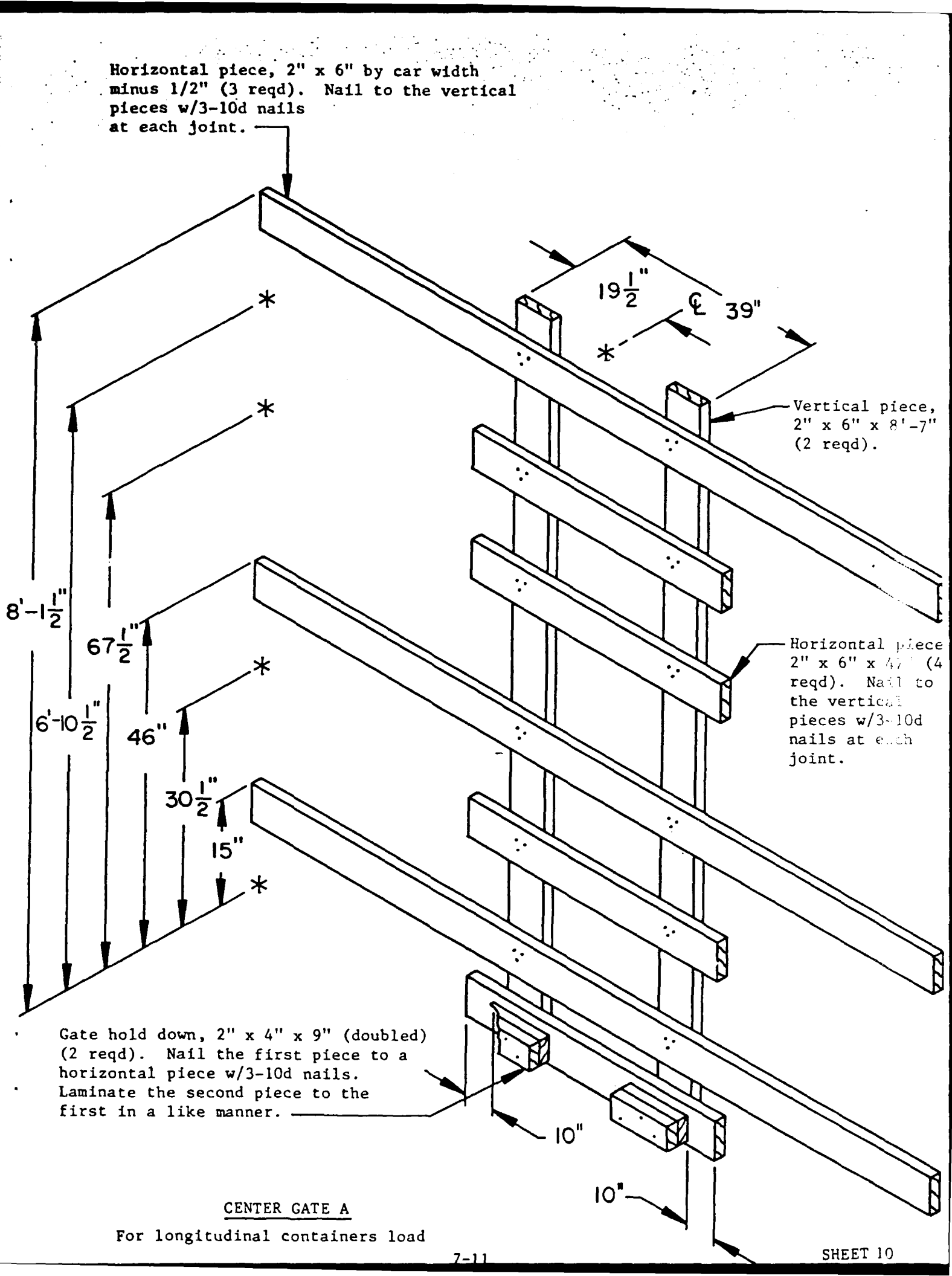
PA116 PALLET CRIB FILL GATE

12 reqd for lengthwise load



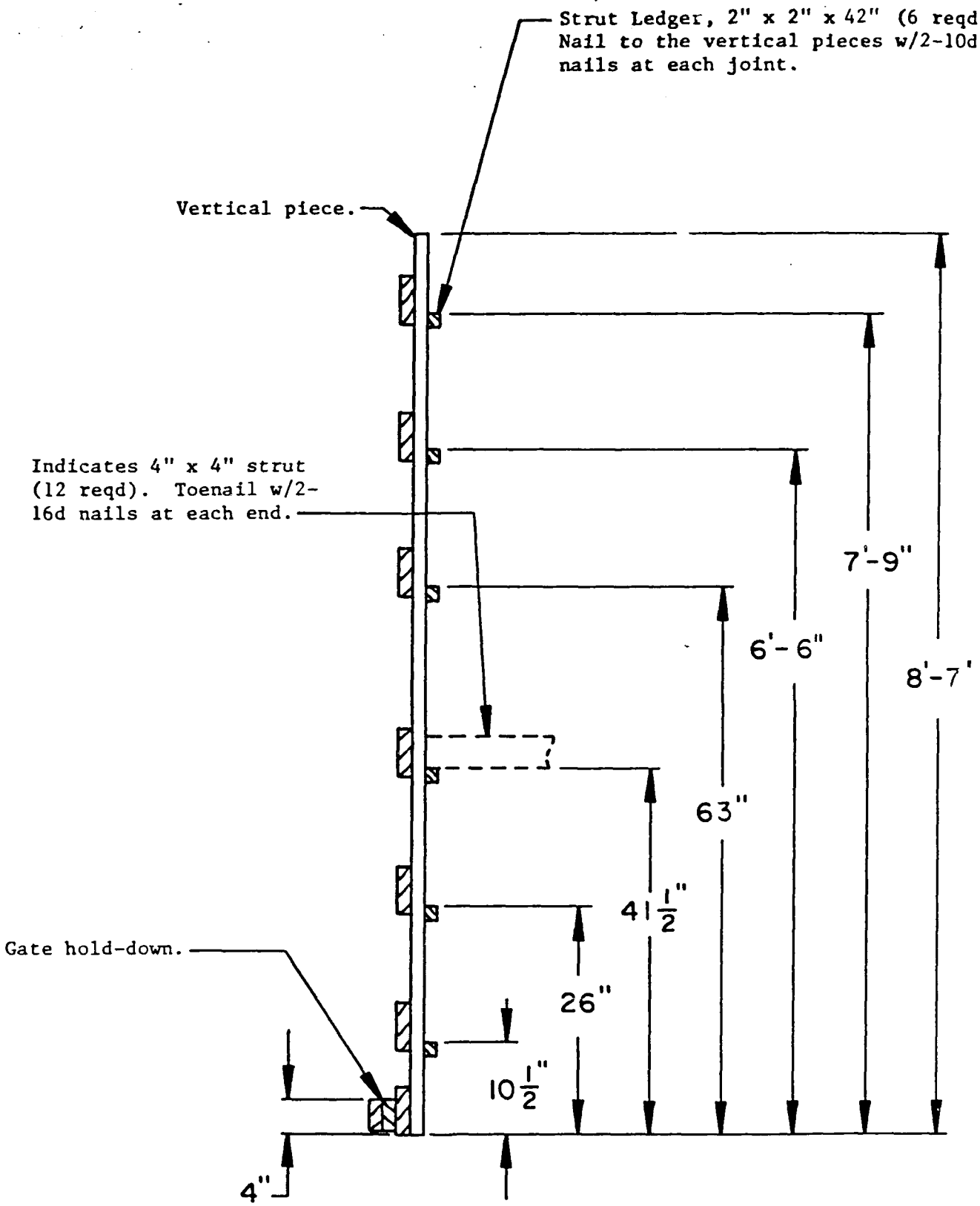
SEPARATOR GATE

1 reqd for lengthwise load

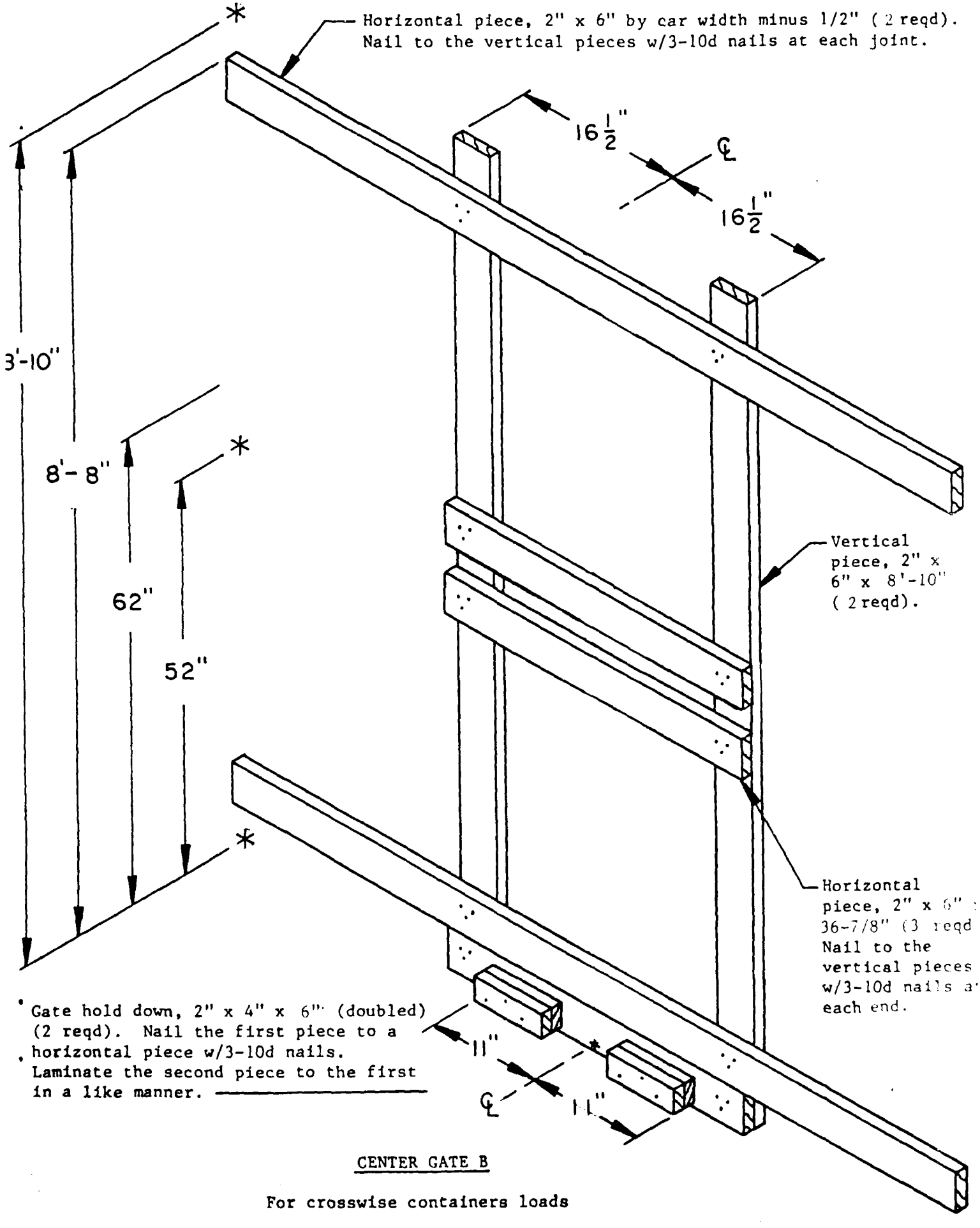


CENTER GATE A

For longitudinal containers load

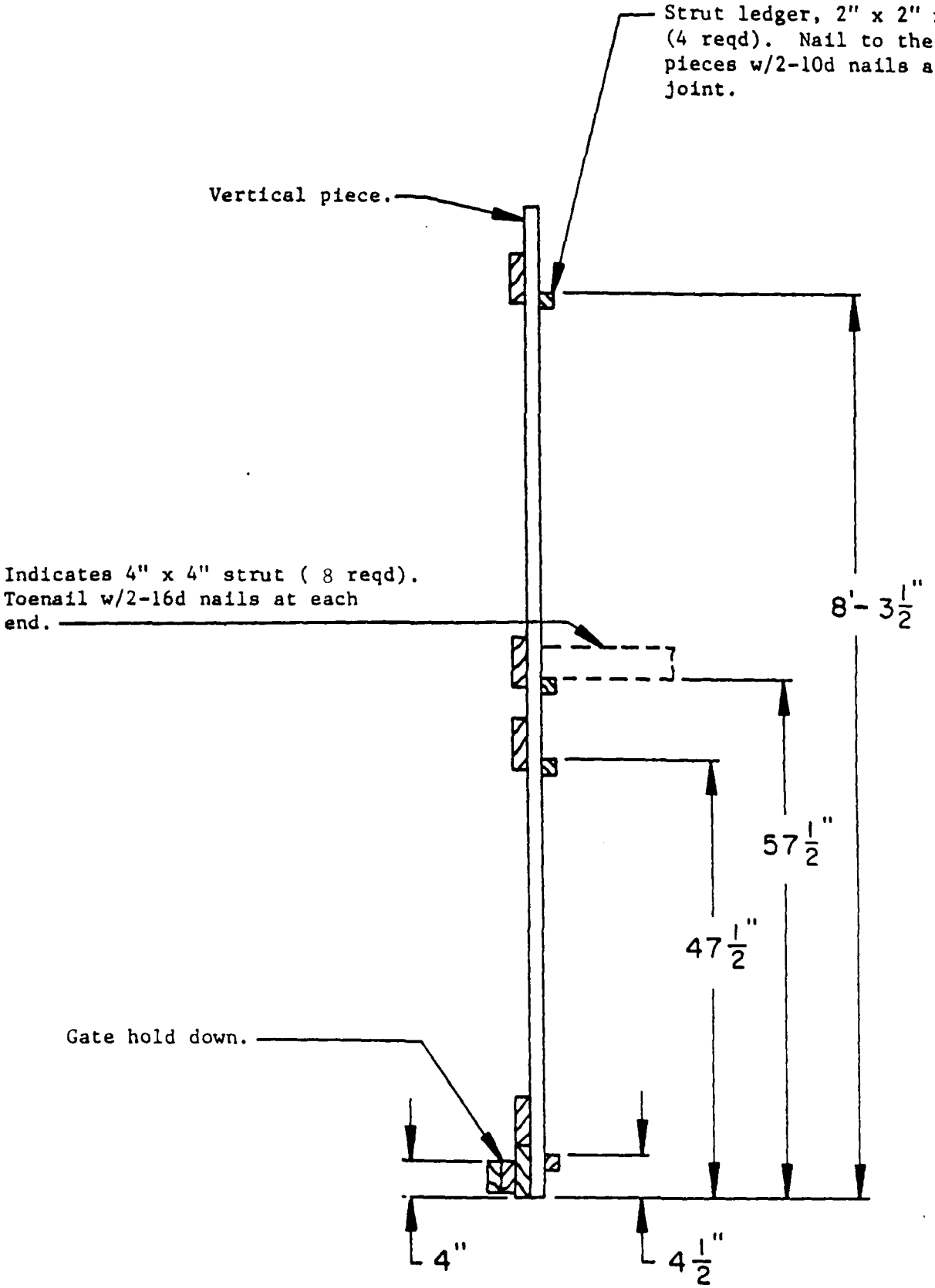


END VIEW OF CENTER GATE A



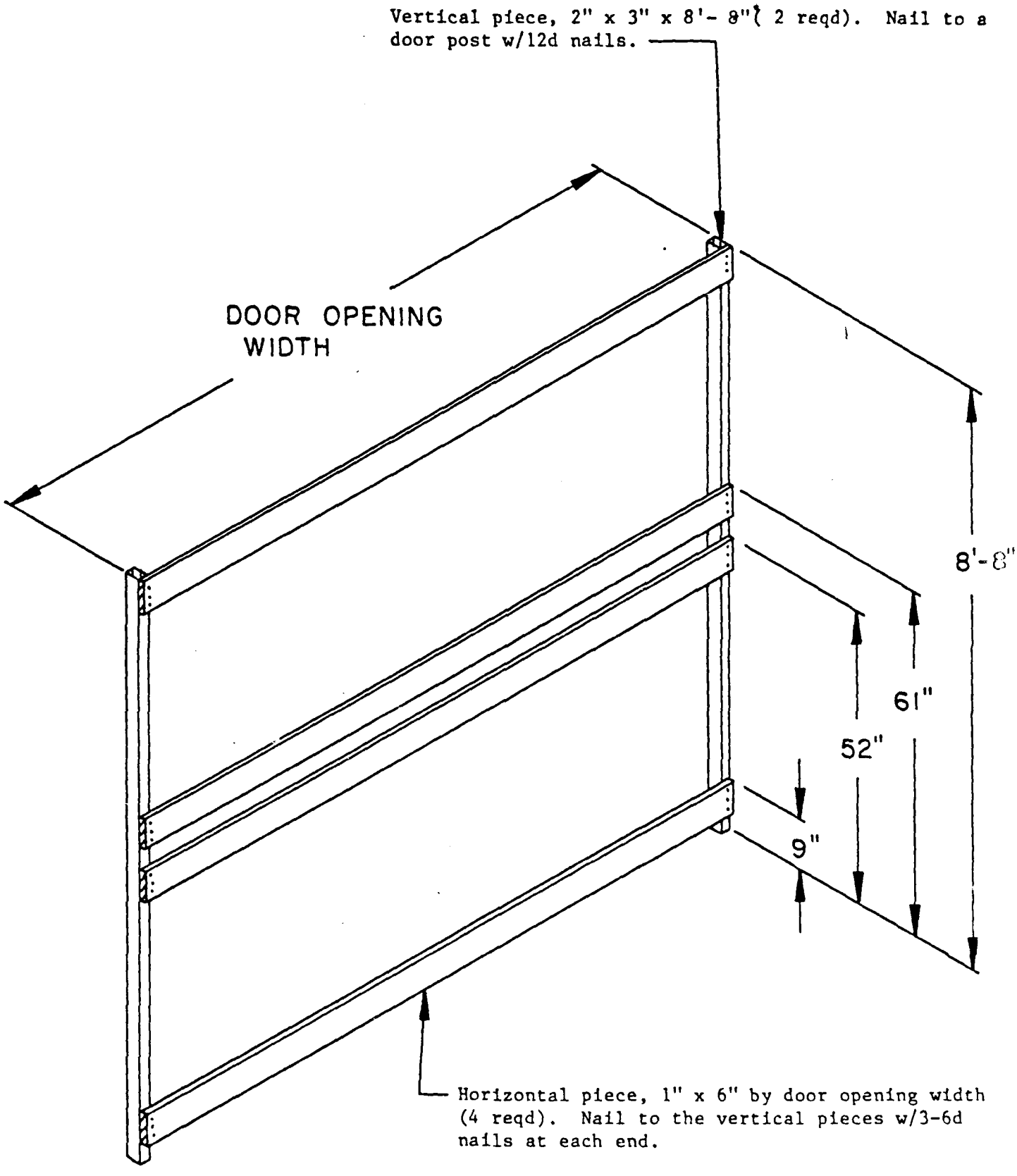
CENTER GATE B

For crosswise containers loads

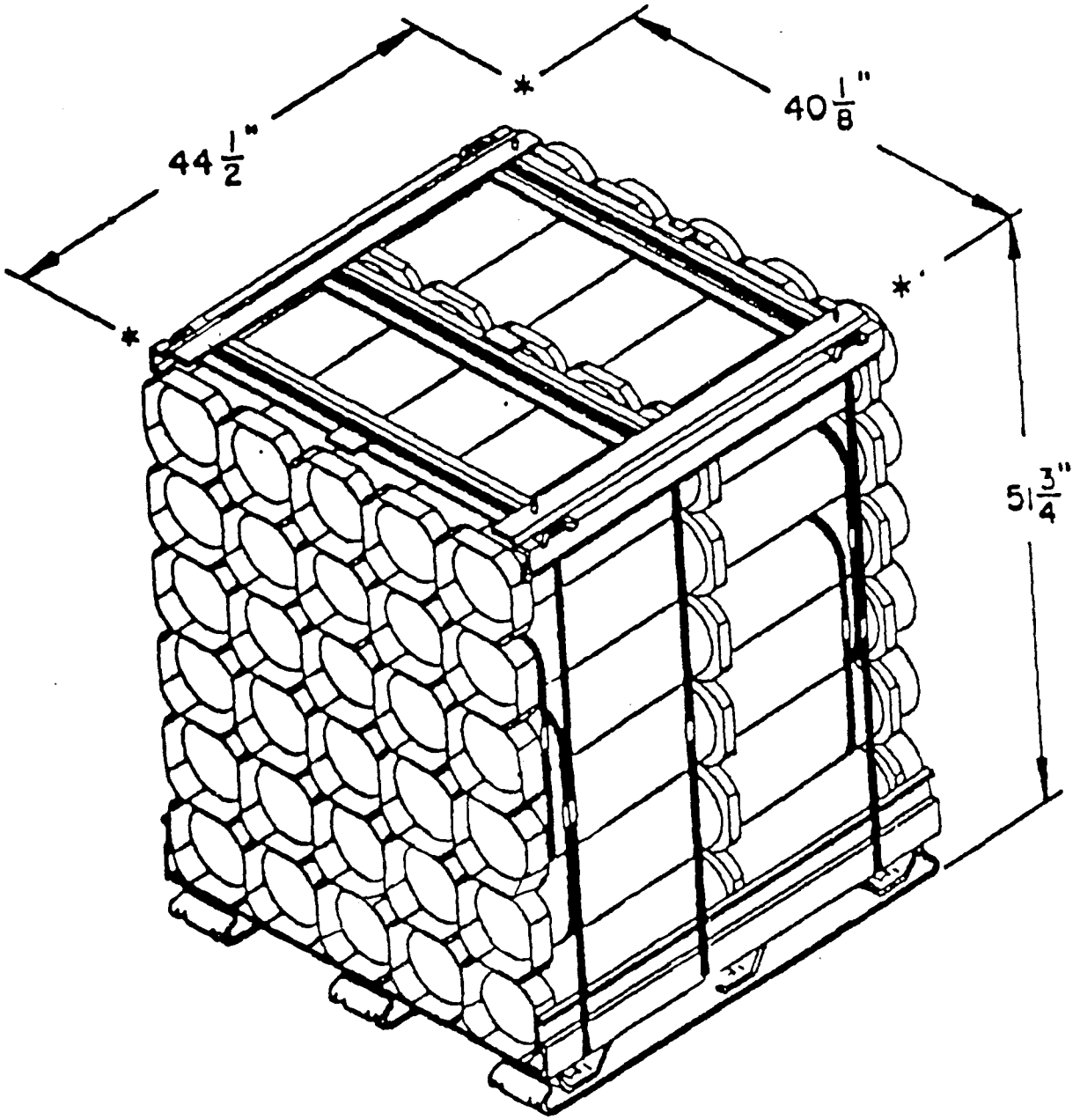


END VIEW OF CENTER GATE B

SHEET 13



DOORWAY PROTECTION



PA116 PALLET UNIT (FILLER)

Container----------30 each @75 lbs (approx)
Cube----------53.5 cubic feet (approx)
Gross Weight----------2,444 lbs (approx)